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Technology Review

Edited at the Massachusetts Institute of Technology

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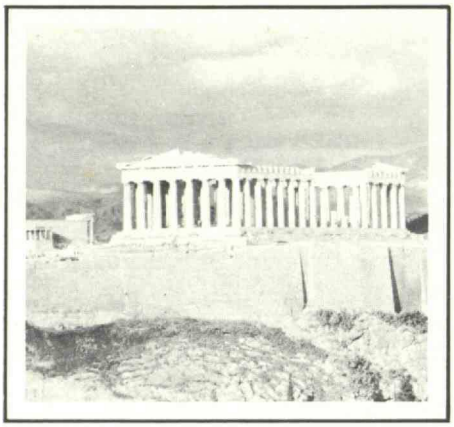

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Jumping Into the Loch

This issue contains the first complete publication anywhere in the world of new American evidence on one of the most fascinating scientific mysteries of this century — the existence of the legendary "monster" in the Loch Ness. The mystery is by no means solved. We and our authors have sought simply to lay out all the facts as concisely as possible — to report what was done and what was found. Whatever conclusions they draw, our readers will be better prepared by far to follow and understand future developments as the search continues.

The Sources of Recessions

Another "first" in this issue, as well — the first magazine publication ("Modeling Cycles in the National Economy") of results stemming from a system dynamics model of the national economy now under development by Professor Jay W. Forrester and his colleagues in the M.I.T. Sloan School of Management. Five years ago (January, 1971) *Technology Review* was privileged to publish Professor Forrester's first description and results of the system dynamics "world" model from which later came the famous study, *Limits to Growth*. (Reprints of Professor Forrester's description of the system dynamics method and the "world" model — "Counterintuitive Behavior of Social Systems" — are available from the *Review* at 50 cents each.)

Letters

Nuts and Bolts

"Educating Engineers to Deal with Shortages" by Benjamin L. Averbach (*June, pp. 36-41*) is long overdue, but it is interesting to note that the very problem he describes has been caused by the educators themselves. For too long a time, beginning in the mid-to-late 1950s, engineering education was designed to have the top students spend their undergraduate hours preparing to enter programs in graduate school where, more often than not, the research was tied to some program whose usefulness was either nonexistent, or significant only in an advanced technological situation. The result has been a concentration in the academic or research and development areas of these generally more capable people who went on to graduate school. Is it, therefore, any wonder that the average practicing engineer in industry is a follower rather than a leader?

We do need, as Dr. Averbach suggests, closer contact not only between the student and industry, but also between faculty and the basic, sometimes dirty, and almost always frustrating industrial environment. The lack of basic knowledge about everyday metallic materials of construction is appalling. This situation must be corrected, or we will not only have "some bean counter telling us what to do" but will also not have the vaguest idea why he wants us to do it.

William B. Eisen
Syracuse, N.Y.

Ozone and the Public Health

Charles E. Kolb's discussion of possible effects of chlorine on stratospheric ozone (*"The Depletion of Stratospheric Ozone," October/November, pp. 38-47*) could leave some readers with the impression that the postulated chlorine/ozone catalytic chain reaction is known to occur in the stratosphere. This is not at all the case.

Current models assume the chlorine/ozone reaction repeats 10,000 or more times. It is not known, however, whether the reaction occurs one time, ten times or 10,000 times under stratospheric conditions. There may well be competing reactions which remove chlorine from the chain postulated by the theory. The article mentions in passing that reactions with stratospheric particles "may be important" in this regard.

It should be noted also that, if the postulated 10,000 cycles is incorrect by a factor of 10, the predicted fluorocarbon/ozone problem would be of borderline significance; if it is incorrect by a factor of 100, the whole theory would be rendered of no significance from a public viewpoint. This kind of margin of error is well within the uncertainties of the model.

Additionally, the question of whether continued use of fluorocarbons represents a serious threat to the ozone layer has been rendered academic both by industry's early pledge to discontinue production of the compounds involved if creditable research shows these fluorocarbons pose significant hazard to the environment or to public health, and by the government's subsequent interest in regulating use of these products if research shows there indeed would be a problem if no action were taken.

Most scientists knowledgeable in this area agree, however, there is no significant risk to taking the three years necessary to complete research efforts needed to test the predictions of the fluorocarbon/ozone theory. There is general scientific agreement that the difference between ceasing worldwide production of fluorocarbons 11 and 12 now, and three years from now, is an added ozone depletion (if the theory is proved correct) of about 0.5 per cent. This is an insignificant amount both from the viewpoint of the ozone level and public health.

With the certain serious economic disruption in an industry employing 53,000 workers in the aerosol segment and more than a million workers in all segments (source: U.S. Department of Commerce), reason suggests strongly that in the absence of risk, the consequences of precipitate regulatory action are severe enough to dictate against any regulatory action at this time.

R. L. McCarthy
Wilmington, Del.

Mr. McCarthy is Product Technical Manager of the Freon Products Laboratory, E. I. du Pont de Nemours and Co.

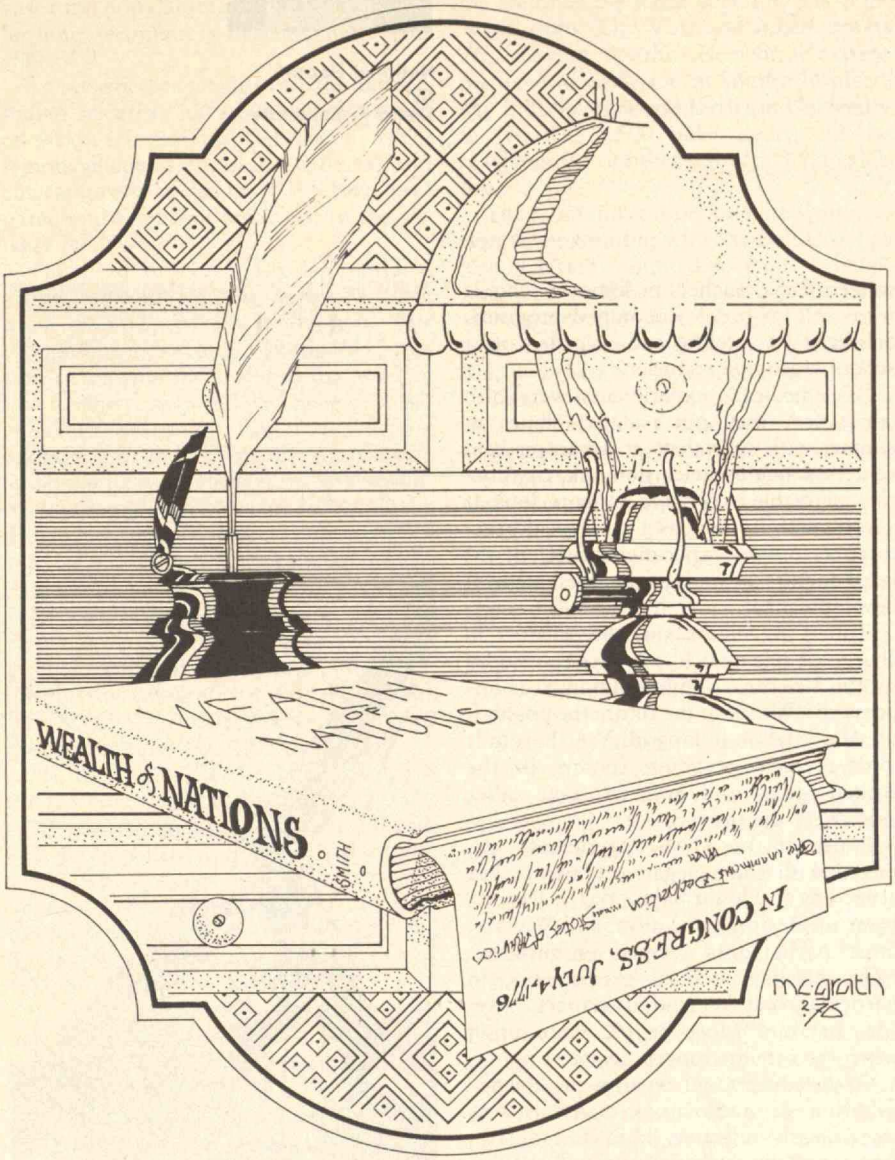
Dr. Kolb responds:

As Mr. McCarthy himself points out, the question really isn't whether the atomic chlorine-induced chain reaction destroys ozone (it does), but whether the chain reaction cycles enough times to efficiently destroy significant amounts of ozone. Mr. McCarthy is correct in pointing out, as I did in my article, that unknown processes not now included in atmospheric chemistry computer models may change the conclusion of those models. However, it is fair to note that these unknown processes could also make the impact of chlorine from Freons more, not less, significant.

I do agree with Mr. McCarthy that current models indicate that we have a few years of grace before we decide whether it is necessary to stop the production and/or atmospheric dispersal of Freons. I am sure we both hope that research now in progress will resolve the main areas of contention before decisions with serious economic impact must be made.

Fruitful Inconsistencies: The Legacy of Adam Smith

Technology/Society
by
Kenneth E. Boulding



The origins of great movements are often obscure. It is doubtful whether any of the founding fathers gathered in Philadelphia in July, 1776, had read a book published in London a few months earlier. Yet 2,000 years from now, the book's anniversary may seem more significant than July 4th.

The book, of course, is *An Inquiry into the Nature and Causes of the Wealth of Nations* by Adam Smith, a professor of moral philosophy at the University of Edinburgh and a well respected, if slightly eccentric, bachelor. Smith's literary and intellectual reputation had been firmly established by the publication of *The Theory of Moral Sentiments* 17 years earlier. I do not know exactly when *The Wealth of Nations* reached the American colonies, but there may have been some copies in the Philadelphia bookstores in that momentous July.

The coincidence of dates is certainly appropriate. Apart from a certain apostasy with regard to the tariff, the book of 1776 could have served as a blueprint for the nation. It is not surprising that Adam Smith was friendly towards the American Revolution — mainly, one suspects, because he thought it a good thing for Great Britain, however doubtful its advantage to the Americans. Speaking of pre-Revolutionary affairs he says, "Under the present system of management, therefore, Great Britain derives nothing but loss from the dominion which she assumes over her colonies." One would like to see Smith's caveat — that dominion feeds only pride and special interests, and injures the general interest of the dominator — inscribed over the portals of every government in the world.

Adam Smith expected a parliamentary union of Britain and the colonies. But, he warned, "in the course of little more than a century, perhaps, the produce of America might exceed that of British taxation. The seat of the empire would then naturally remove itself to that part of the empire which contributed most to the general defense and support of the whole." One might almost suspect that George III deliberately provoked the American Revolution in hopes that it would prevent the removal of the throne to the other side of the Atlantic, and the reduction of Great Britain to a minor province of a great American empire.

Laissez-Faire Liberalism

As it developed, the United States followed many of the patterns outlined in *The Wealth of Nations*. The idea of separation of church and state, for instance, is Adam Smith's. He saw that this might be better for the church than for the state. He thought that free competition among sects "might in time probably reduce the doctrine of the greater part of them to that pure and rational religion free from every mixture of absurdity, imposture, or fanaticism, such as wise men have in all ages of the world wished to see established; but such as positive law has never yet established and probably never will establish in any country . . ." Adam Smith was also convinced of the need for publicly supported education, although he thought parents should pay something to ensure the teachers' efficiency. He was even in favor of publicly supported entertainments (to cheer up the dour Scots).

On the other hand, there is no doubt that he believed in competition. The dangers of its absence in education, as in everything else, were most clearly represented in the scandalous situation at Oxford, where ". . . the greater part of the public professors have, for these many years, given up altogether even the pretense of teaching." Indeed, Smith's commentary on education and on religion in *The Wealth of Nations* still stands as an unrivalled exposition of the sociology of

(Continued on p. 12)

Information from the Sky

National Report
by
David F. Salisbury

The gleaming wire-dish antennae — ten feet across — look out of place among the earthen buildings of rural, southern India. Next year, they will be moved 8,000 miles to the remote hunting villages of the Cree Indians in Alberta, Canada. These modernistic wire totems are linking primitive cultures to more advanced cultures via communications satellite. The experiment is unique, and fascinating.

The present generation of "talksats" and "telsats" requires large and expensive ground terminals to pick up the faint broadcast signals. But the two experimental U.S. satellites broadcasting to receivers in India and North America operate at power levels 10 to 20 times greater. As a result, even portable receivers are possible. And in the next decade, it may become economical to transmit high-quality color television directly to isolated communities around the globe without stringing thousands of miles of wire and building hundreds of microwave transmission towers. Eventually, satellites may tie widely scattered groups together with live, two-way television.

Teleteaching

The two experimental satellites are the sixth Applications Technology Satellite (ATS-6) launched in May, 1974, and the Communications Technology Satellite (CTS) orbited this January. CTS is supported jointly by the U.S. and Canada; the Japanese have a similar satellite on the drawing board.

After a year and a half, the technical performance of ATS-6 has exceeded expectation. During its first year, the satellite hovered in geostationary orbit 22,300 miles above the Galapagos Islands. From there, its large antennae broadcast to Alaska, the Rocky Mountains, and Appalachia.

Courses for elementary school teachers in career training and the teaching of remedial reading were carried via satellite to five Appalachian states. And in addition to the usual audiovisual instruction, the teachers participated in live discussions and seminars although physically separated by hundreds of miles.

Meanwhile, in remote areas of the western U.S., teachers in some 75 schools were able to order videotaped programs delivered by satellite and recorded on a school videotape recorder.

"Telemedical" experiments were also conducted; they put isolated clinics in contact with specialists at urban medical centers. Using the television link, city doctors were able to observe patients, look at x-rays, and discuss cases with local practitioners. Other experiments briefed isolated doctors on some of the latest medical developments.

Robert B. Shamaskin, the scientist in charge of telemedical projects sponsored by the Veterans Administration, was impressed: "We see in the future the possibility of a satellite linking all V.A. hospitals with medical teaching centers in the United States and even in some other countries," he says.

Praise of the ATS-6 experiments was mixed with some negative reaction, but according to Phillip Balasz of the Department of Health, Education, and Welfare, most participants seemed enthusiastic. "The Alaskan medical experiments, in particular, had tremendous impact," says Mr. Balasz. "Most people were upset when the satellite moved away."

Of the educational experiments, the distribution of audiovisual materials was most clearly effective. H.E.W. estimates that a similar satellite system will provide educational material to the 100,000 primary and secondary schools in the U.S. for a fraction of a penny per hour per student.

H.E.W. officials point out, somewhat defensively, that the aim of such a system is not centralized control. Rather, the system would act as a locally controlled distribution network. Audiovisual material would be broadcast directly to students, but would be taped first on videorecorders. Thus, materials could be reviewed first by faculty, school administrators, and parents.

Failure to Communicate

After completing its year of U.S. experiments, the satellite moved over East Africa. From there, its broadcast footprint covers most of the subcontinent of India,

Two advanced communications satellites are connecting remote areas to the outside world. In India, Indian scientists and technicians have installed receivers and television sets in 5,000 villages. Programs on farming techniques, hygiene, and birth control broadcast from N.A.S.A.'s ATS-6 satellite may be the answer to India's enormous communications problem — and may help to diminish starvation, disease, and overpopulation. (Photo: N.A.S.A.)

where yet another video experiment is underway. In India, an estimated seven out of ten people live in small villages, more than 500,000 of them. As a result, attempts to solve India's pressing problems — starvation, disease, and overpopulation — are hindered by an enormous communications problem: how to reach this vast rural population with information on farming techniques, hygiene, and birth control.

To see whether satellites are the answer, Indian scientists have built receivers and television sets and installed them in 5,000 remote villages. Educational, cultural, and entertainment programs have been prepared and are being broadcast to the villages by ATS-6.

The head of N.A.S.A.'s International Office, Arnold Frutkin, returned from India recently with this evaluation: "Although it is in black and white, the reception is magnificent — far better than in this country with all its interference." More significant, Mr. Frutkin observed a rekindling of Indian interest in a satellite system of its own. He says the Arab countries, Indonesia, and Iran are following the Indian experience closely.

Since the broadcast began, school attendance has jumped by 30 per cent. Adults have been captivated by the electronic screen, and many have requested more educational information, and more information about the outside world. The Indian government has decided to hook up half the receivers with ground lines in order to continue the experiment when the satellite returns to the U.S.

"There is no question but that satellites will bring video to many areas of the world which don't now have it," says Leonard Jaffe, N.A.S.A.'s Assistant Director for Applications and one of the key figures in communication satellite development.

Inevitable Growth

Perhaps the most convincing proof of the success of ATS-6 in the U.S. is the formation of the Public Service Satellite Consortium, headquartered in San Diego, Calif. The Consortium has 45 members, including the State of Alaska, the National Educational Association, and the University of California. Many participated in ATS-6 experiments.

The group began meeting in January at the time of the CTS launch. Its objective is to define the needs of the public service community that can best be met by satellite systems, and to help influence the evolution of satellite communications along lines compatible with those needs. "We are looking at the future in practical terms, staying away from the blue sky stuff," says John Witherspoon, the Consortium's president.

As Consortium members have realized, major growth in satellite communications appears inevitable in the near future. One timely indicator is a proposal which the Public Broadcasting Service submitted to the Federal Communications Commission in February. P.B.S. suggests linking its stations by satellite instead of the present land lines. Such an arrangement would be economical, improve reception, and allow more programming flexibility, P.B.S. maintains.

Most experiments on this newest satellite continue the work begun by ATS-6 investigations. The V.A. and other groups are carrying on the telemedical experiments. And professors at Stanford University in California and Carleton University in Ottawa, 2,500 miles apart, will be teaching one another's students via satellite.

The Communication Satellite Corporation is cooperating with the Red Cross to test receivers mounted in vans, helicopters, and small boats. These mobile units should provide disaster relief workers with a telephone and high-speed teletype link with Red Cross headquarters.

The greatest difference in CTS experiments is the heavy Canadian involvement. "We feel that satellites are the only way we can provide color television to every Canadian community of over 500 people, which is our goal," says John Davidson, Director of Canada's Department of Telecommunications. He stresses the advantages of the small, inexpensive, and portable receivers which CTS makes possible. When mass-produced, the receivers will cost no more than today's color television set, he says.

Canada is using the satellite much as ATS-6 was used in India. In many northern areas where Indians live, a resource boom is beginning. Development of Canadian oil, natural gas, and minerals is gaining momentum. Because the natives have no legal claim to the land and lack the skills to profit from its exploitation, their lives are being disrupted to no benefit.

But soon, members of the Dogwood tribe who live in Yellowknife, in the Northwest Territories, will receive computer-aided instruction in their native language, broadcast from the University of Western Ontario. In Alberta, "Cree people are being introduced to white culture by the mass media," says Larry Desmeules, head of Project Iron Star. "You are trained to tell fact from fiction in television programs. But the Cree are not. So we will give them some knowledge of urban life, to help introduce them to the culture. We also want to help with alcoholism, unemployment, and other social problems."

David Salisbury is Science Editor for the Christian Science Monitor *and a regular contributor to* Technology Review.

Cancer and the National Health

Washington Report
by
Colin Norman

An important political debate of the structure, funding and management of the nation's biomedical research program has been simmering in the scientific community for some time, and is about to come to the boil in Washington. Though there's every likelihood that rhetorical hyperbole will rapidly obscure the central issues, it's just possible that a fundamental, and long overdue, examination of the federal role in health research is in store.

Two catalysts are likely to initiate the debate. First, a number of senators and congressmen are beginning to take a critical look at the way in which cancer research funds have soared over the past few years, while support for other areas of biomedical research has languished. And second, a top-level presidential commission, which has been hearing evidence and soliciting opinions on the federal government's biomedical research efforts for the past year, is due to issue its findings at the end of April.

Wars and Rumors of Wars

The question of how funds for biomedical research would best be distributed among various programs is indeed hoary. But since the National Cancer Act was declared in 1971, the problem has steadily grown more pressing.

The figures speak for themselves. Between 1970 and 1975, funds for the National Cancer Institute rose by 280 per cent, from $182 million to $669 million. The budget for the National Heart and Lung Institute doubled (a bill calling for war on cardiovascular disease was passed in 1972, but it hasn't attracted money as effectively as the cancer war). Yet the budgets of the remaining biomedical research institutes in the National Institutes of Health (N.I.H.) rose by only 20 per cent. In that five-year period, the share of N.I.H.'s budget devoted to cancer research rose from 16.6 per cent to about 35 per cent.

That phenomenal growth has taken place with few hard questions asked, particularly in Congress. The reasons are clear enough: cancer is a dread disease and it is the nation's second largest killer; cancer research therefore has strong political support. But there are, nevertheless, signs that Congress is now willing to take a closer look at the cancer program in particular, and priorities for biomedical research in general.

The first such indication came late last year when a group of Senators, led by Gaylord Nelson (D.-Wisc.), proposed that the growth of funds for the National Cancer Institute and the National Heart and Lung Institute should be slowed a little, while funds for other research institutes should be given a bigger boost. Though the move was soundly defeated — 62 votes to 19 — it nevertheless marked a significant change from previous years, when cancer funds have been voted through with little opposition.

The proposal received impressive support from several former directors of N.I.H. Dr. James Shannon, who headed N.I.H. from 1955 to 1963, a period of rapid expansion, wrote a letter to the supporters of the proposal affirming that "there is merit, indeed high merit, in a pause in program expansion [in cancer and heart programs] in order to assess the basic strategies of these endeavors." His successor, Robert Q. Marston, has also supported a more balanced funding among N.I.H. institutes. He has cautioned, "It is important to remember that dollars spent in support of science must be spent for sound science. Support of bad science can be very harmful because someone has to eventually undo the bad science and this can be a very costly and wasteful process."

Correct Strategy

Though the Senate beat back the drive to redistribute increases in funds for biomedical research, the administration, undaunted, will take up the gauntlet again this year. Mr. Ford's budget proposals for fiscal year 1977 include no increases for the National Cancer Institute, while they provide a welcome boost for every other institute. Explaining the proposals to reporters, Assistant Secretary for Health Theodore Cooper said that the administration decided such a strategy is correct in terms of the potential for scientific advances.

Mr. Ford's budget requests for the entire health area are probably moot issues since Congress is unlikely to approve them, but his position on cancer research funding should at least prompt fresh thoughts on our research priorities.

There is still another reason why politicians are more willing to take a hard look at the domination of cancer research in the biomedical research budget. In previous years, it has been politically difficult for senators and congressmen to question cancer spending given the program's wide popular appeal. But recently, a new issue has developed which makes such scrutiny easier and more likely: the question whether the cancer war is concentrating on cures and treatments, at the expense of finding ways to prevent the disease.

The starting point for discussion of that issue is the widely held belief that most cancer in man is caused by chemicals in the environment. Thus Russell Train, head of the Environmental Protection Agency, has suggested that the entire federal health effort may be skewed in favor of treatment rather than prevention. And last year, a top-level advisory committee of the National Cancer Institute expressed "astonishment" at the poverty of research in environmental carcinogenesis in the cancer program.

The issue has certain political appeal, since it gives members of Congress a chance to demonstrate, by supporting a shift in the cancer program's priorities, their commitment to prevention of the dread disease. Though the result is likely to be that money for cancer research will be more closely scrutinized, the issue is likely to become confused.

Second Thoughts

A recent statement by David Baltimore, 1975 Nobel Laureate and M.I.T. Professor of Microbiology, at an N.I.H. meeting to discuss possible controls on genetics research, is noteworthy. The fact that 80 per cent of human cancer may be caused by environmental factors, Dr. Baltimore suggested, "means that 80 per cent or more of the disease is caused by various aspects of our lifestyle including our diet, our smoking habits, our sexual habits,

etc." He noted that, "Human beings are very conservative about their personal habits and do not easily change them. Even if we identify the causes of breast cancer, cervical cancer, prostate cancer, colon cancer, bladder cancer, etc., it is unlikely that we are going to be able to design a civilization that will be acceptable to the population and that will prevent occurrence of these terrible diseases." Therefore, he argues, "we should certainly make every effort to understand how our lifestyle causes cancer, but we must also push forward on a more basic attack on the cancer problem." In other words, the issue is certainly not clear, though the debate so far has occasionally styled it so.

The central question in all this, of course, is not simply whether the Cancer Institute should be allowed to grow at the expense of other areas of biomedical research, but also how the priorities should be formulated. So far, funding priorities have been set in large measure according to political considerations. The ideal, of course, would be to fund research which is most beneficial both to science and society.

That, one hopes, is where the presidential commission on federal support for biomedical research should help. The commission, which was established 18 months ago by a bill sponsored by Senator Edward M. Kennedy (D.-Mass.) has been given a broad mandate to examine our *(Continued on p. 12)*

Strangers in Paradise

Technology/Environment
by
Ian C. T. Nisbet

Early in 1827, Dr. Gerrit Judd, a medical missionary on the island of Maui in Hawaii, was called to treat a mysterious itch reported by Hawaiians who lived near pools of standing water and along streams behind the village of Lahaina. The affliction was caused by a new kind of *nalo* (fly) described as "singing in the ear." To the Reverend William Richards, descriptions of the flies suggested a pestiferous insect from which the islands had previously been free. Inspection confirmed his fears: the first mosquitos had arrived.

According to a recent chronicler, investigation "back-tracked the trail to the previous year and the ship *Wellington*, whose watering party had drained dregs alive with wrigglers into a pure stream, and thereby to blot one more blessing from the Hawaii that had been Eden." The *Wellington* had taken on water on the west coast of Mexico, water infested with the tropical form of the mosquito, *Culex quinquefasciatus*.

Nothing was done to isolate and destroy the new colony, and indeed probably little could have been done. Together with other blots and blessings of civilization — including goats, rats, negotiated peace, Christianity, measles, chicken pox, medicine, liquor, money, firearms, trading companies, influenza, and tourism — the night mosquito spread rapidly through the islands and is now established in the Hawaiian environment.

Garden Varieties

Prior to its discovery by Captain Cook in 1778, the Hawaiian archipelago was filled with strange and wonderful plants and animals. Remote islands throughout the world form natural laboratories for evolution. On rare occasions an organism arrives by chance at an isolated island and can establish a viable colony. It enters an environment free of natural competitors and enemies, expands rapidly and, through natural selection, adapts to its new environment. Where the environment is varied and fragmented — as it is on a volcanic archipelago such as Hawaii — a new immigrant can form several colonies which rapidly diverge.

The phenomenon of "adaptive radiation," in which a single immigrant evolves over a long period to become a diversified group of species, is best illustrated in Hawaii, the most isolated tropical islands in the world. Hawaii's native flora and fauna manifest many unique species and show extraordinary variations.

The Hawaiian "honey-creepers," a family of birds found nowhere else on earth, are a spectacular illustration of adaptive radiation. From a common ancestor, they have differentiated into a bewildering variety of forms to fit the islands' specialized ecologies. Some feed on nectar, others on fruit, insects, or seeds. Some resemble parrots, others finches, woodpeckers, or hummingbirds. Many are brilliant shades of red, yellow, or green. Altogether, 22 species and 24 island varieties have been described, although many were already disappearing when naturalists first arrived to study them.

Night Visitors

The destruction of Hawaii's unique flora and fauna was begun by Captain Cook himself, who released pigs and goats as a meat supply for subsequent landing parties. Cattle, horses, sheep, deer, and rabbits were added in quick succession. Rats arrived early, and when these and other pests were found damaging the sugar cane crop, mongooses were imported in a vain attempt to control them.

As a result of these immigrations, the native forests were steadily depleted, to be replaced by crops in the lowlands and by alien trees introduced on the slopes. As the native flora dwindled, so did the fauna: Hawaii now claims more extinct species than all continents of the world combined. Forty per cent of the unique forms of honey-creeper alone are extinct or endangered.

For some time, the disappearance of endemic birds seemed to be explained sufficiently by the loss of natural habitats, together with the introduction of such predators as rats and mongooses. Yet, many of the surviving birds seemed restricted to altitudes higher than 2,000 ft. above sea level, even on islands where their natural habitats and foods were available locally in the lowlands.

Then in 1968, someone made an interesting observation. When native birds were trapped in the mountains and brought in cages to sea level, they quickly sickened and died. The diseases — bird pox, caused by a virus, and avian malaria, caused by a protozoan parasite — are transmitted by the night mosquito. Kept in screened, mosquito-proof cages, the birds remained healthy. Conversely, birds introduced from continents where these diseases are endemic fluorish in the Hawaiian lowlands. So the native birds must lack natural resistance to these alien diseases.

No Defenses

Although the precise role of the diseases in the destruction of native bird fauna will never be known, it seems reasonable to conclude that they now help to limit the birds' distribution and will obstruct their recovery and re-introduction. Fortunately the mosquitos are tropical, and do not survive well above 2,000 ft. It has been speculated that the introduction of the temperature form of *Culex quinquefasciatus* to Hawaii could be disastrous for the rare species that still have a precarious foothold in the mountains.

This phenomenon tells us some important things about island environments. Remote islands don't simply support unusual forms of life: their remoteness protects those forms against the stresses to which continental forms have had to adapt. The problems experienced by the birds parallel those of the Hawaiian people, who suffered substantial mortality during the last century from introduced diseases such as measles.

Island ecosystems are especially vulnerable to environmental impacts. And when losses occur, they are the sadder because they doom unique and irreplaceable biological forms.

Ian C. T. Nisbet, who writes regularly for Technology Review, *is Associate Director of the Scientific Staff of Massachusetts Audubon Society.*

The Loch Ness Press Mess

Special Report by Dennis Meredith

When news first broke last fall of the existence of new photographs of the fabled Loch Ness monster, the avalanche of publicity made it clear that there was indeed a monster run amok in our midst — the press. Those photographs and others not presented before are published and analyzed for the first time in this issue of *Technology Review.* Whether or not the photographs are convincing, the press reports about them offer examples of the dangers of human error, innuendo, and shoddy workmanship on the part of media representatives.

The latest controversy began in earnest in November, 1975, when portions of a book, *The Loch Ness Story,* appeared prematurely in a British newspaper. In the book excerpt, author Nicholas Witchell described new photographs of the monster that were being kept under wraps by their owner — the Boston-based Academy of Applied Science, a research group whose president is lawyer-engineer Robert H. Rines. The Witchell story climaxed a wave of rumor that fall, which had spawned some heavy betting on the monster's existence. A symposium sponsored by the Royal Society of Scotland and the University of Edinburgh was scheduled secretly, although details had leaked to the press.

The British press exploded at the news of the photographs, first announcing and then damning the evidence. One outcome was the cancellation of the Edinburgh symposium, although a shorter exposition was held at the British House of Commons. Another result was that Rines and his colleagues were deluged with journalists, and their work and reputations were called into question. Herewith, a selective look at some of the press' allegations.

R. R.-Nessie: Exam by Potshot. R.

After the initial revelations, zoologists at the Natural History Museum in London who had examined the photographs issued a statement that they were not convinced that the photographs showed anything animate, and that a hoax was entirely possible, although they expressed confidence in the integrity of the investigators. Before any of the facts of the Academy work had been presented publicly, various press stories alleged that the photographs were of logs, Viking ships, divers, a fake movie monster previously sunk in the loch, and other such paraphernalia. Even though these theories were pure opinion ventured by various members of the public, they nevertheless rated banner headlines in Britain and were even given credence in America, where things were cooler. In its January 9 issue, *Science* magazine published a brief article which mentioned a Scottish librarian's opinion that the photographs were of a fake movie monster lost in the loch. What *Science* did not say was that the librarian had not seen the photographs when he ventured that opinion, but relied upon third-hand press descriptions.

Science, Time and practically every other magazine and newspaper reporting on the controversy also took great pains to point out what they considered another significant discovery — that the scientific name bestowed upon Nessie by British naturalist Sir Peter Scott and Dr. Rines — *Nessiteras rhombopteryx* — is a perfect anagram for "Monster Hoax by Sir Peter S." Rines and Scott have both pointed out that the name is a logical one, in terms of biological nomenclature, and Rines answers with another anagram of his own: "Yes, Both Pix Are Monsters. R." One also wonders why the journalists, wordsmiths that they are, did not sit down and have more fun with the name, anagramwise, discovering that many arrangements are possible. We have, and so all the subheads in this article are also perfect anagrams for *Nessiteras rhombopteryx.*

Press Riot B.R. Honesty Exam

The press allegations also focused on Dr. Rines' reputation and that of the Academy. The organization was described as "shadowy," "vague about its membership," and being "less impressive in fact than its name suggests." From interviews with Dr. Rines and examination of the press clippings, it appears that these allegations reflect more an inability of reporters to track down facts about the Academy, than the Academy's lack of substance. Indeed, the Academy is just as impressive as its name suggests. According to a readily available handout on the Academy, its Advisory Board of Governors includes:

— Isaac S. Blonder, Chairman; Chairman of the Board, Blonder-Tongue Laboratories

— Richard H. Bolt; Chairman of the Board, Bolt Beranek and Newman, Inc. (formerly Associate Director, National Science Foundation, and Professor of Acoustics, M.I.T.)

— Edward L. Bowles; consulting engineer, Professor Emeritus, M.I.T.

— Francis W. Davis; consulting engineer and inventor.

— Charles Stark Draper; Director, Charles Stark Draper Laboratories, and Institute Professor Emeritus, M.I.T.

— Ivan M. Faigen; President, Chu Associates, Inc.

— Kenneth J. Germeshausen; formerly Chairman of the Board, EG&G, Inc.

— Paul R. Johannessen; President, Megapulse, Inc.

— W. E. P. Johnson; Partner, Cleveland and Johnson

— Walter Juda; President, Prototech, Inc.

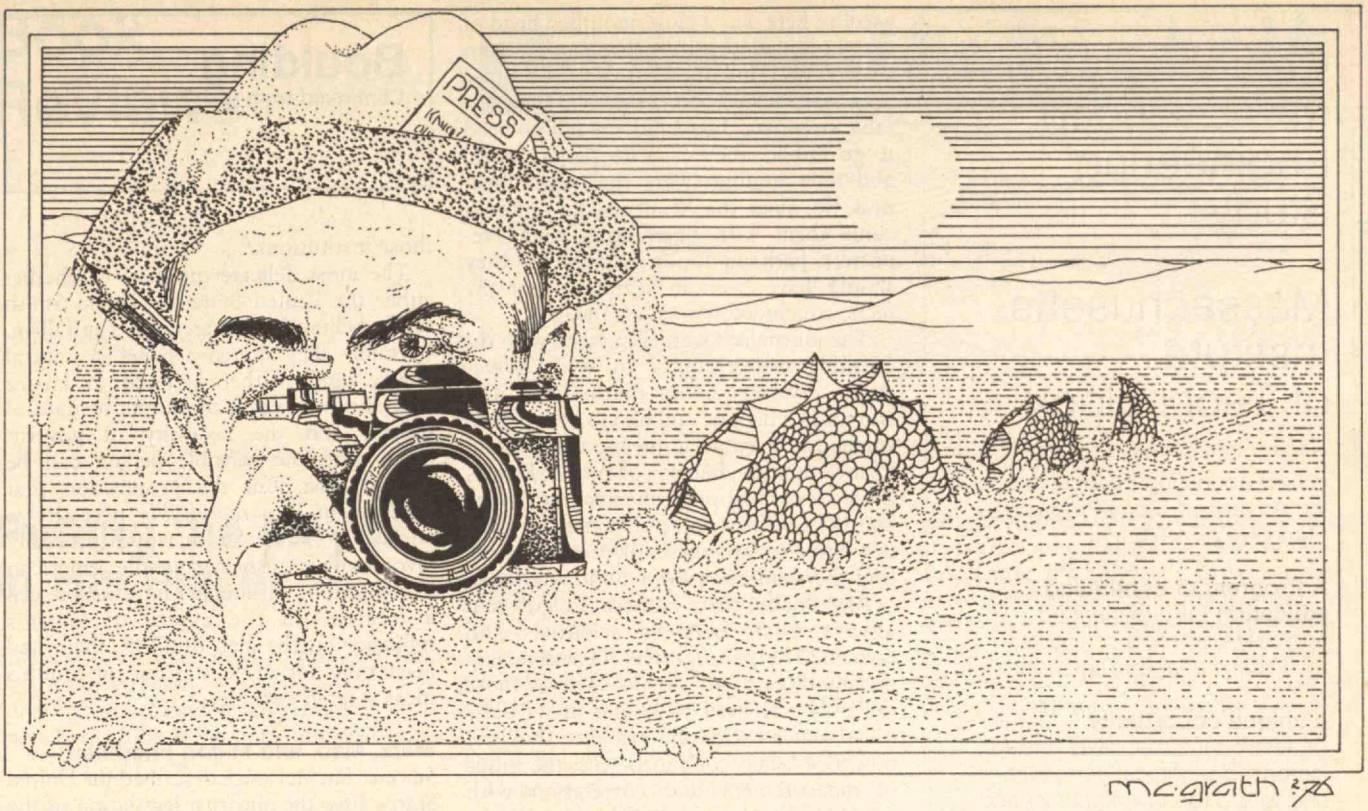
— Frederick G. Keyes; Professor of Physical Chemistry Emeritus, M.I.T.; President, Keyes Scientific Corp.

— Nelson H. Shapiro; Shapiro and Shapiro, Washington, D.C.

— Jason Weisman; Chairman of the Board, Energy Sciences, Inc.

— Charles W. Wyckoff; President, Applied Photo Sciences, Inc.

The Academy sponsors seminars and symposia on patent law and engineering; presents its Medal of Honor to notable inventors; officiates for the New England section of the Junior Science and Humanities Symposia for high school students, sponsored by the U.S. Department of the Army; has sponsored the first educational computer research laboratory in Taiwan; and has supplied aid to various research projects in archaeology. It sponsors research on patent protection for inventors and projects in aiding communication among inventors, universities and government.



Another central theme in press reports about the Loch Ness photos was that Rines was but a lawyer, and only a "dedicated amateur," and the Academy research team less than competent. Indeed, it was with almost palpable surprise that the British magazine *New Scientist* wrote on December 4 that, "Technologically, Rines' team is more high-powered than many of his critics give him credit for." (The short biographies of the Loch Ness team members at the end of this issue's "Search for the Loch Ness Monster" should make the point of the investigators' competence.)

Press Trix Bare Money Hots

And, of course, throughout the affair, the press continually stressed the pecuniary aspects of the photographs.

Most reports of the bidding for the photographs took the form of vague hints that unnamed interests were offering large sums for the photographs, as if the specific information were impossible to obtain. Dr. Rines and his colleagues were subtly cast as sharpies looking for big bucks. But as Dr. Rines told a press conference when queried on the subject: "What are you asking me for? Your organizations are the ones who are doing the offering." There was evident confusion within the media organizations themselves as to what they were doing. For instance, it was reported that *National Geographic* had been offered the photographs for a large sum, but turned it down, and that *Time* magazine had backed out of the bidding. According to Rines, however, it was *National Geographic* who approached him, not vice versa, and negotiations were amicably broken off when Dr. Rines refused to hold the pictures back until *National Geographic* could consider financing a more comprehensive expedition.

Extortion by Press Shamer

The case of *Time* seems a bit less than responsible. According to Dr. Rines and his colleagues Charles W. Wyckoff and Robert Needleman of the Academy, *Time* personnel had talked enthusiastically of a cover story to coincide with the scientific conference on the monster, and had asked for and received various advance statements from zoologists on the photographs' authenticity. However, there then followed a period of confusion, in which *Time* waffled, and then decided against publishing a cover story on the subject. Dr. Rines refused to allow publication of the pictures in black-and-white, which *Time* offered instead, because of the poor reproduction capabilities involved. After Dr. Rines broke off negotiations and asked for his material back, there came a phone call from *Time* to Dr. Rines' son, in which it was intimated that the Academy scientists would be treated in a future article as hoaxers (all of this without any expert examination by *Time* of the photographs and surrounding evidence). Rines' son, Robert L. Rines, cautioned the *Time* reporter against this, offering background material on the Academy, which was refused on the grounds that "there isn't time."

What followed must be construed as one of the major gaffes of the entire controversy. On January 12, *Time* published an article lumping the Loch Ness findings with the "bigfoot" of the Pacific Northwest. Of the Academy it was said, "The institution, which has no connection with any university or recognized research organization, is vague about its membership and seems to have financed little in the way of study on its own."

Then followed an inexplicable attempt to lump the Academy with a New York lawyer, unconnected with the Academy, who had purchased a chimpanzee, thinking it was the bigfoot. Said *Time*, "An academy member, Peter Byrne, has searched for the legendary bigfoot. A New York lawyer has acquired an animal that some feel may even be bigfoot. Michael Miller bought the creature, described as resembling 'a bald chimpanzee with an ear job and a sour disposition,' from an animal show for $10,000." A case of defamation by journalistic juxtaposition?

Ness Pix Mar Hot Beer-Story

In general, why was this particular scientific controversy subject to so much misinformation and innuendo? First, the Loch Ness monster has been in the past but a barroom tale, to be resurrected by the press on slow news days. As author Nicholas Witchell says of the new evidence, "It was very tricky . . . for the media, which didn't know quite with what degree of seriousness to treat the story. After all, it isn't every day that one of your favorite fun characters shoves two fingers up at you and turns into a page-one science sensation."

The Loch Ness monster wasn't the only unusual creature to the press; there were also Robert Rines and the Academy. Unlike the press-conscious, highly-financed public science agencies journalists were

used to, here was a close-mouthed head of a tight-lipped private organization, who wanted no publicity whatsoever until the photographs had been examined by reputable scientists. The Academy felt no need to go public; they used no public funds, and their findings were their own business. So, since the Academy did not welcome them with open arms, many reporters, perhaps not as assiduous as they should have been in searching out the facts, concluded it was a fraud.

The journalists were also faced with the crushing responsibility to write *something, anything,* about the findings. The story was a big one and had to be reported somehow, even if it meant using uninformed opinion, hearsay or rumor. Hence, the wide circulation of the anagram story, and the issuance and publication of various opinions about the pictures even before they had been viewed and analyzed.

And finally, there is the basic gulf that always exists between scientists and laymen. The photographs themselves are not good, certainly not as clear as those the public is used to seeing in its daily press. But as scientific evidence they are powerful when combined with the kinds of measurement and correlation with sonar evidence possible. This correlation was often not considered in press stories, even by reputable science writers reporting on the subject. One said the "body-head" photograph "could still be taken for a sad-eyed mole with a long tail," perhaps an unfair simile considering that reputable experts' analyses had revealed the object to be at least around 20 feet long.

The moral to the whole affair seems clear: when it comes time to re-examine old beliefs, the examination should be done with a healthy skepticism toward those reporting the evidence as well as toward those proclaiming it.

Dennis Meredith is Managing Editor of Technology Review.

Norman

Continued from p. 7

priorities and to suggest how the federal effort might be improved.

Coming just as the budget debates in Congress begin, the report is likely to have far-reaching impact.

Colin Norman is Washington Correspondent for Nature *and a regular contributor to* Technology Review.

Boulding

Continued from p. 3

those institutions.

The most delicate question is whether either the United States or Adam Smith really believed in anarchistic capitalism. Certainly they shared a belief in natural liberty, and neither believed in laissez faire. Both asserted the limits to natural liberty, and the necessity of government, since no sensible person can be an anarchist. But the proposition that government is a *regrettable* necessity is one which Adam Smith would probably favor, and is enshrined in the American Constitution. Although I have never seen a treatise on the extent of Smith's influence on the men of 1789, there had been time for at least some of Smith's ideas to gain currency.

Marx, Mao, and Milton Friedman

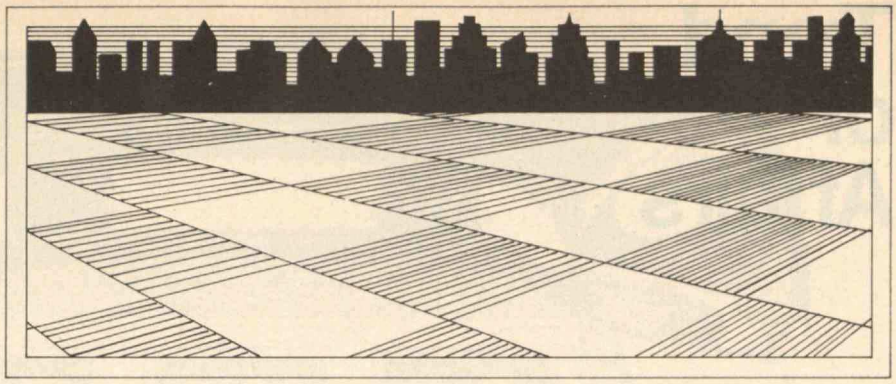
Sumner Slichter once described the United States after the antitrust legislation of the 1880s as a laborist rather than a capitalist society. One can argue that while United States government has always thought business useful, and capitalists tolerable, or even to be encouraged, it has had no special fondness for either businessmen or capitalists.

Oddly enough, the same thing is true of Adam Smith. The roots of Marx as well as of Milton Friedman are deep in *The Wealth of Nations.* In fact, the idea that employers have unfair advantage in the labor market comes straight from Smith, to be embraced with a will later on by Karl Marx: "As soon as the land of any country has all become private property, the landlords, like all other men, love to reap where they never sowed and demand a rent even for its natural produce." This is hardly the talk of a good republican, but it is talk we have heard since from Stalin and Mao.

The greatness of Adam Smith is rooted in fruitful inconsistencies. In the very first chapter of *The Wealth of Nations,* Smith comes within an inch of seeing that the crucial factor in production is not labor but knowledge. If only he had gone that extra inch and seen that the factors of production were not labor, land and capital, but know-how, energy and materials, how much grief the world might have been saved. But this is a lover's quarrel; I have had a long love affair with *The Wealth of Nations.* On its 200th birthday it is still a young book, with a great future.

Kenneth E. Boulding is Professor of Economics and Director of the Institute of Behavioral Science at the University of Colorado.

Book Reviews



Putting the Mayor in His Place

Mayors in Action: Five Approaches to Urban Governance
John P. Kotter, Paul R. Lawrence
New York: John Wiley and Sons, 1974; xi + 287 pp., $14.50

Reviewed by Arnold M. Howitt

When New York City was teetering on the edge of default, and municipal, state, and federal officials wrestled with knotty fiscal, policy, and partisan issues, a bystander might have paused to reflect on a small irony of political fortune: the reputation of John V. Lindsay.

During the "urban crisis" of the 1960s, Mr. Lindsay had been a national symbol of resistance to decay and disorder. In shirtsleeves, he walked the streets of Harlem and Bedford-Stuyvesant to keep the peace; he applied modern management techniques to the maze of municipal bureaucracy; he spoke eloquently for greater federal aid for urban problem solving. But by the mid-1970s, Lindsay had become the symbol of municipal profligacy — throwing money at social problems, caving in to the exorbitant demands of public employee unions and other interest groups, irresponsibly juggling accounts and going deeper into debt to conceal the slide toward bankruptcy. Last fall New York City finally secured state and federal aid to prevent default at the cost of substantial cuts in services, and perceptions changed once more. A few commentators mused whether the dynamic and resourceful Lindsay might have bargained better with Albany and Washington than did Abe Beame.

Fathoming Political Behavior

What can we reasonably expect a mayor to accomplish? While it is surely true that leadership is only part of the political process, it is also true that social science has made only modest strides toward understanding the interdependencies between leaders and their political environments. What shapes a leader's objectives in office? What factors facilitate or impede his capacity to manage and coordinate the complex bureaucratic system he formally heads? Under what circumstances can he draw support for his objectives from the general public, other levels of government, and key nongovernmental actors? What is the likely response to new kinds of demands articulated by his constituents?

These questions are relevant not only to social scientists but also to policymakers at all levels of government. For example, disappointment in the Great Society programs prompted moves late in the Johnson years and during the Nixon Administration to strengthen the mayors' authority to implement federal programs. Yet, federal officials had only fuzzy notions of how those expanded powers would affect policy; they simply hoped for improvement. To achieve ordered social change and to avoid frustrated expectations, we need to understand better how our institutions perform.

Crucial Contexts

In *Mayors in Action,* John P. Kotter and Paul R. Lawrence of Harvard School of Business report on a comparative study of 20 big-city mayors during the 1960s. Theirs is the first effort to collect systematic data about mayoral behavior in more than a handful of settings.

Drs. Kotter and Lawrence first describe and categorize variation in three arenas of mayoral behavior: agenda setting, network building and maintenance, and task accomplishment. The authors find five patterns of mayoral behavior characterized by increasingly detailed and long-range objectives, more varied resource exchanges with groups in the environment, and more ambitious and complex modes of carrying out tasks. These behavioral patterns emerge from the interaction of the mayor's personality, skills, and motivations; his agenda, or the specific goals he defines; the network of resources and support available; and the city's social, economic, and political conditions. These variables have simultaneous effects on one another: when they are compatible — a complex agenda, for example, requires a well-developed support network — they are said to be "aligned." According to Drs. Kotter and Lawrence, mayors usually strive for a condition of "coalignment," in which all possible combinations are compatible. But they are not always successful, since not all variables — including their own abilities — are within their control. Conspicuous failures of mayoral leadership, therefore, stem from chronic nonalignment of the variables.

Admirably, the authors strive to develop a framework for comparative research. Few accounts of mayoral behavior are sensitive to questions theoretically interesting to social scientists, and most of them focus on one or a few cities. Drs. Kotter and Lawrence have therefore greatly expanded the information available about contemporary mayors. They have also emphasized the importance of the political, social, and economic constraints on a mayor's behavior, constraints too frequently underestimated or ignored by other analysts.

Participation and Demands

Since an exploratory study such as *Mayors in Action* aims to introduce and sketch new ideas, it is not surprising that the book leaves room for refinement. For example, the "city" variable is only loosely developed. As a result, Drs. Kotter and Lawrence fail to deal with political participation as it creates "demands" on mayors. For instance, if they had studied New York City, they could explain much of Mayor Lindsay's behavior in terms of his response to newly mobilized political groups, including blacks and public employees, and to such declining groups as political party organizations. In fact, the "urban crisis" — in New York City and elsewhere — can probably be better explained as pressure to satisfy new participants in city politics than as a systematic deterioration of living conditions in American cities.

In exclusively adopting the "coalignment" or systems approach, Drs. Kotter and Lawrence too readily abandon causal inferences about relationships among their variables. In some situations, the

(Continued on p. 70)

Trend of Affairs

Trends This Month

TELEPHONES

Everyman's Computer Terminal

Futurists have effervesced over numerous future worlds containing home videophones, kitchen computer terminals, and the world's libraries at one's fingertips. However, such systems are far off because of the tens of billions of dollars that would have to be invested in equipment, even with inexpensive microelectronics.

Until such miracles come to pass, however, many advances can be made using today's venerable telephone system, as evidenced by several recent developments.

In one experiment in Minnesota, telephone lines are being used to read home gas, water, and electric meters. The system, now being tested in about 200 homes in Mankato, Minnesota, automatically dials a customer's home. If the line is not busy, the system queries a data-gathering unit in the home, and records the impulses transmitted by the unit. These impulses represent the readings of the customer's meters. The automated meter readings are then transferred to punched cards and given to the utilities for billing. The system does not interfere with normal phone service, even to the extent of disconnecting itself if the customer picks up a phone while meter reading is in progress.

Unlike the automated meter reading system, most experiments using the telephone for data transmission utilize push-button telephones as simple computer terminals. Some savings banks in Minnesota, New York, Pennsylvania, and Connecticut now offer a computerized Pay-by-Phone service in which customers can use push-button phones to instruct a computer to pay their bills.

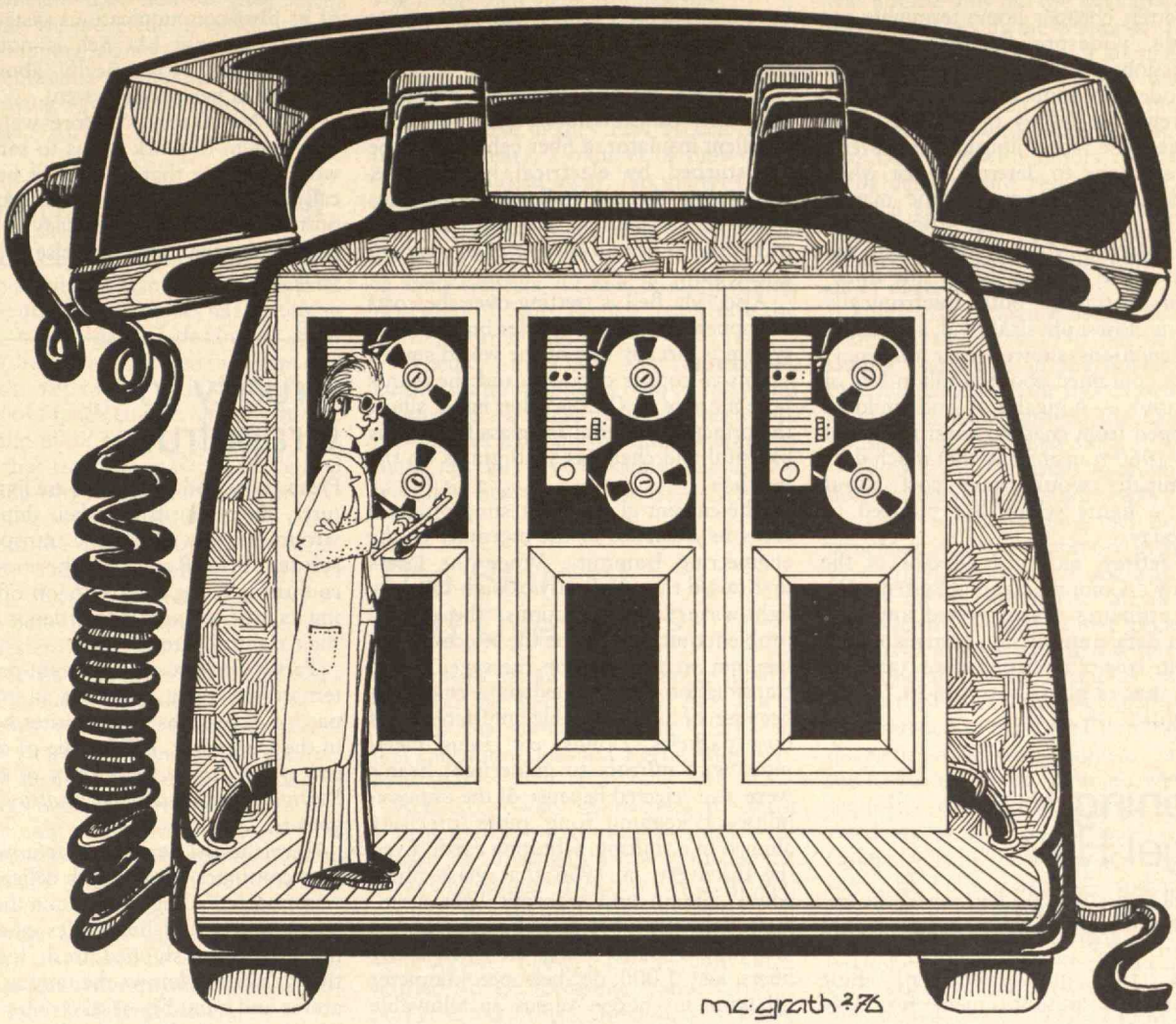
To use the system, a customer calls the computer, punches out a secret code, and then punches a code number and amount to be paid for each bill. Any instructions or amounts can be repeated back and mistakes can be corrected, or help from a human operator can be requested. According to its developers, the system remedies a major fault of many automated bill-paying systems, in which a customer has difficulty controlling payment times or amounts. (For the price of a long-distance call you can try the system out by following the instructions in the box to the right.)

The system, developed by Telephone Computing Service, Inc., of Seattle, Washington, is financed by investing the increased savings deposits attracted by the system. For instance, while depositors receive the standard 5¼ per cent on their savings, the banks reinvest at the current money market rates of 8½ per cent. The first bank to introduce the service, Farmers and Mechanics Savings Bank of Minneapolis, reports a profit of $125,000 on the system in the first full year, and developers say they expect an "explosive growth" in Pay-by-Phone.

In Toronto, Canada, customers of Simpsons Sears Ltd. can use push-button phones to order catalog merchandise directly from a computer. Simpson's Comp-u-Shop has not only found favor with customers — 94 per cent said they liked it — but it has solved two nagging problems of the catalog retail business: error in transcribing the order, and customer disappointment when the item is out of stock. The customer merely dials the computer, keys in his home telephone number to identify himself, and punches out his order. He will be told immediately if the order is out of stock, and since the order data goes directly into the computer, transcription errors common to telephone orders are eliminated.

The telephone is also finding some use as a data terminal in the office. IBM is developing an office computer system based on a telephone with a cheap display screen attached. Executives can ask the computer for information, dictate letters, calculate, and have calls automatically made at preselected times. The display screen, possibly cheap enough to allow home installation, can display notes, memos, messages or library information.

All these new uses of the telephone involve only small amounts of information, but information that is either needed very quickly or would be more expensive to



Trying Out the Pay-by-Phone Service

Farmers and Mechanics Savings Bank in Minneapolis, Minn., has set up a demonstration number where the computerized "Pay-by-Phone" service can be demonstrated. If you have a push-button telephone, for the price of a long-distance call you can test the service by following these instructions:

— First, assume that you want to pay two bills (National Credit Card, $34.69; Local Department Store, $48.78) and want to transfer $100.00 from your Pay-by-Phone account to your checking account to use for your groceries, etc.

— As a Pay-by-Phone customer you would look at your Pay-by-Phone wallet where the payment codes are listed for those payees that you had authorized from a list of 1,000 (the bank would have your individual account numbers and would have verified them with the payee):

Payment To	*Payment Code*
National Credit Card	2001
Local Department Store	2002
Checking Account	2003

— Dial the Pay-by-Phone teller at Farmers and Mechanics Savings Bank in Minneapolis with a push-button telephone (341-5959 Area Code 612)

— Touch out 88-034752 and the "#" or "action" key when the computer asks for your account number.

— Touch out 8728 and the "#" key when the computer asks for your secret code. These are special practice numbers established so customers could "try" the service at home before signing up.

— To pay the National Credit Card, touch out 2001 and the "#" key when the computer asks for your merchant payment code.

— Touch out 34.69 using the decimal or "*" key and then the "#" key when the computer asks you for the amount.

— To pay the Local Department Store, touch out 2002 and the "#" key when the computer asks for your merchant payment code.

— Touch out 48.78 using the decimal or "*" key and then the "#" key when the computer asks for your merchant code.

— To transfer funds to your checking account, touch out 2003 and the "#" key when the computer asks for your merchant code.

— Touch out 48.78 using the decimal or "*" key and then the "#" key when the computer asks for the amount.

— To conclude your transactions and get the total of your payments, touch out "0," "2" and the "#" key.

While you are making transactions you can:

— Have any instructions, code numbers, or amounts repeated back to you by pressing the "action" key "#";

— Correct a mistake, by pressing the "error" key "*" and then the "action" key, "#";

— Request a personal Pay-by-Phone teller for help by pressing "0" for operator and the "action" key, "#". — *D.M.*

process on a cost-per-unit basis otherwise. Until better, cheaper home terminals are available, widespread telephone data transmission will probably be limited to such modest amounts of data.

Lawrence R. Jeffrey of MITRE Corp. has done some rather unusual and revealing calculations to determine just when mass data transmission for the masses would be economic. In an article in the MITRE *Matrix*, Mr. Jeffrey figured just what it would cost to "ship" the *Encyclopedia Brittanica* both electronically and by its closest physical rival, air freight. His calculations showed that the encyclopedia contained about a billion bits of information — a gigabit — and could be air-shipped from coast to coast for about $50. In 1960 transmitting that much data electronically would have cost about $2500, a figure which has plunged to $125 today.

Mr. Jeffrey, technical director of the company's Communications Systems Division, estimates that expected improvement in data transmission systems would lower the cost of electronic data transmission to that of physical transport "in the near future." — *D.M.*

Phoning Via Angel Hair

Ma Bell is a colossal lady; when she bestirs herself even slightly, notice should be taken.

Thus the importance of Bell Laboratories' announcement last December that it is beginning to field test an experimental system to transmit information over hair-thin glass fibers using tiny solid-state lasers. According to George C. Dacey, Bell Labs' Vice President for Transmission, a 2,000-foot cable containing over 100 fibers will be installed in ducts and manholes at Bell's Atlanta, Georgia facility. The actual length of the fiber circuit could grow to miles, due to joining of fibers at either end of the cable to form loops.

The testing of a long glass fiber circuit is a sweet victory for communications technologists who have spent the last fifteen years drooling over the theoretical possibilities inherent in laser transmission. A laser light-glass fiber communications link could carry 100 billion bits of information per second, a thousand times more than today's cable or microwave link capacities, because of the short wavelength, and thus, high carrying-capacity of light. A glass fiber cable the thickness of a lamp cord could carry as many messages as 10,000 ordinary phone wires, a highly significant achievement in a phone system suffering an advanced case of electronic atherosclerosis. As cable TV, computer communications, and phone service have increased over the last few years, city utility ducts and the transmission capacities of conventional circuits have become quite congested; a glass fiber technology could significantly alleviate the transmission squeeze.

But there are also other advantages to glass fiber transmission. Since glass is an excellent insulator, a fiber cable would be undisturbed by electrical interference, eliminating the crosstalk in phone lines which enables a listener talking to his aunt in Peoria to hear someone elses' aunt in Pocatella.

Also, Ma Bell is fretting over the costs of copper used in cables. Her buried cable system is already one of the world's most extensive copper deposits, and she wants little more of it. On the other hand, silica, the principal material for glass fibers is as plentiful and cheap as sand grains on the beach.

The current glass fiber testing program owes its existence to the ingenuity of the engineering fraternity. When the lasers first raised the possibility of high-capacity light-wave communications, the central problem quickly became the selection of a medium to use for the message. Aerial transmission was immediately ruled out because of unpredictable interference of dust particles, clouds, etc. Long metal pipes with mirrors to guide light beams were also rejected because of the impossibility of keeping long pipes precisely aligned in a shifting, vibrating earth. Even the discovery in 1966 that glass fibers could contain and transmit light seemingly held little promise, because of the heavy light losses along the fiber. Early fibers lost 1,000 decibels per kilometer (db./km.) in energy, versus an allowable loss of only a few decibels for long-distance transmission. But in 1970, Corning Glass announced an optical fiber with a loss of 20 db./km., two years later reducing this to 4 db./km. Bell Labs announced in 1974 an even lower loss in its glass fibers — 1.6 db./km. for some wavelengths.

Bell Labs has also come up with solutions for manufacturing the glass fibers without bubbles or impurities, plugging them into one another and into circuitry, and transmitting and detecting information-carrying light over them. It has also increased the lifetimes of the semiconductor lasers which are prime candidates as light sources. These speck-sized lasers are essentially sandwiches of aluminum gallium arsenide and gallium arsenide between metal contact plates. When electricity is applied, electrons within the crystals give off excess energy in the form of coherent light.

So far, Bell Labs engineers have achieved lifetimes of 16,000 hours — about two years — for the lasers, and they believe 100,000-hour lifetimes are possible. The Atlanta experiments will also utilize light-emitting diodes as light sources. These sources would be used in less-complex — but lower capacity systems.

Bell Labs' advance to semi-field testing of its fiber-communications system is significant because Ma Bell is notoriously cold-blooded economically about what she uses in her phone system.

Says Mr. Dacey, "Before we put any new system to work it has to satisfy real world criteria; that is, it must be technically and economically feasible, and demonstrate the ability to satisfy a genuine need better than anything else available." — *D.M.*

FOOD

Cruelty to Grapefruit

Fresh fruits and vegetables are living creatures, highly sensitive to their shipping environment, says California transport consultant Eric Rath. Furthermore, this country is doing a terrible job of delivering its little vitamin-laden friends intact to their rightful eaters.

Perishables are an important part of international trade, as well as an important part of Americans' diets, writes Mr. Rath in the December, 1975, issue of the *Journal of the American Society of Heating, Refrigeration, and Air Conditioning Engineers.*

Nevertheless, he said, current rail transport continues to treat such delicate cargo very poorly, failing to maintain the proper temperatures and humidities essential to the quality of shipped fresh foods. Although science knows the unique temperatures and humidity necessary for the best transport of fruits and vegetables, technology has done little about implementing them. As trucking costs rise with gasoline prices, rails should be ready to take up the slack, but their outmoded refrigerator cars keep fruits and vegetables too cold, control temperatures imprecisely, and have not yet advanced beyond such simplistic methods as piling ice on fresh vegetables to maintain humidity. Such icing methods are certainly not applicable to the high-volume transport needed today, says Mr. Rath. Also, inflation has prevented the costly investment necessary to upgrade rail facilities.

Mr. Rath cited some figures: according to a military study, over 40 per cent of the lettuce, celery, tomatoes, and other soft fruits shipped to Europe are spoiled by the time they arrive. Claims for losses and damages of rail shipments of perishables in 1975 were $293 million, up 26 per cent over 1973.

What's needed is a train design which allows 8-foot-high, 45-foot-long containers with properly constructed cooling units to be loaded on board, and plugged in at an efficient electric current level. Such trains could readily interchange their containers with ocean-going container ships.

Since fruits and vegetables are more

energy-efficient food sources than meat, and trains are more energy efficient than trucks, shipping more vegetables by more trains, represents an intelligent approach to improving agricultural efficiency, said Mr. Rath. — *D.M.*

Cooking au Naturel

French cooking has been much distilled since the strenuous banquets of centuries past. The number of courses has shrunk in proportion to a general decline in appetite, and dishes are prepared in far smaller quantities. Yet today, as 200 years ago, the basis of French cuisine remains butter, cream, and more butter.

Now that tradition is being challenged by a group of younger chefs who are experimenting with a lighter, purer menu freed from the disguises of heavy sauces. Its most radical pioneer is Michel Guérard, whose discoveries are said to promise better taste, fewer calories, and less cholesterol.

Some of the techniques of M. Guérard's "cuisine minceur" (slender cookery):

— Cooking vegetables in tightly-closed containers *without* water; slowly, they release and steam in their own juices and so retain maximum nutritive value;

— Combining vegetables and fresh fruit (spinach and pear, for instance) to simulate and perhaps excel traditional creamed dishes;

— Preparing sauces without the butter and cream considered de rigueur. Instead, vegetables and herbs are puréed in a blender, with a bit of defatted stock.

M. Guérard has created menus of three or four courses using no butter and totaling no more than 500 calories apiece — and there are chefs as well as epicures who will deem such virtuosity heresy.

But in the diet-conscious U.S., M. Guérard's methods are sparking a deal of interest. When Robert Jones, Professor of French and Humanities at M.I.T., taught a short course in the "new French cooking" in January, a number of subscribers had to be turned away. No matter that a cookbook of the techniques — now in preparation — has not yet been published. Professor Jones says the "new" cooking is in some respects not new at all, just long obscured in the French repertoire by richer, more lavish dishes.

Whether invention or resurrection, cuisine minceur appears here to stay. And it promises a boon to the food lover whose indulgences have all too quickly come to haunt not only his conscience, but also his waistline, heart, and arteries. — *D.McG.*

The Stain of Red Dye No. 2

The wheels of the F.D.A. revolve slowly: the food dye known as Red No. 2 was banned this January, but its safety was first called into question a generation ago, in 1954.

Red No. 2 was for decades the most widely used food coloring in the U.S. It caused the brown in brownie mixes, the white in frosting mixes, the red in hot dog casings, the caramel color in vinegar. It was found in countless commercial foods — processed cheese, pretzels, candy bars, bottled french dressing, canned fruits, non-cola soft drinks, to name only a few. The dye, a petroleum-derived hydrocarbon compound, was only for show, to dress-up processed foods so as to make them more "attractive" to consumers. It was not the only red dye available to food processors: it was the cheapest.

Why, then, the F.D.A.'s 20-year delay? The evidence against the dye was overwhelming. Tests on rats over the last 20 years have shown repeatedly that the dye was associated with tumors, malignancies, birth defects, and resorption of fetuses (the rat equivalent of miscarriage in humans). These events also occured when chickens were fed the infinitesimal dosage of 25 parts per million.

Public outcry against use of the dye had increased since the 1970 release of two studies conducted in the Soviet Union. One indicated that the dye caused cancer in rats, the other proved the dye's relationship with birth defects.

The F.D.A.'s reaction to public questions following these studies was a federal fandango of sidestepping, including a retrenching of F.D.A. support of the dye. The Agency's conviction was based largely on an experiment carried out 15 years before — inconclusive because the test rats had been confused with the control animals. In 1971, F.D.A. scientists re-ran their own tests and called for a severe cutback in the use of Red No. 2. Industrial advocates retaliated, insisting upon further study. Studies were subsequently carried out by the National Academy of Sciences/National Research Council. Again, the results of these studies were called into question — and again the F.D.A. laid low until this January, when the dye was banned outright.

Despite the food and chemical industries' cries of foul, they've been hedging their bets. Sales of Red No. 2 in 1975 were only half those of 1972, while sales of replacement dyes increased. Allied Chemical, manufacturer of the dye Red No. 40, has planned to raise its production five-

The elaborate pastries pictured in this copper engraving by Abraham Bosse were a fitting, even requisite, climax to French dining ritual. They culminated dishes rich in butter, eggs, and flour with even greater quantities of those sinful staples. Such has been the tradition for centuries, now challenged by the lighter, purer menu of Michel Guérard's "cuisine minceur," or slender cookery. (Engraving: The Bettmann Archive)

fold. Red No. 40 is the most popular replacement for No. 2. While Red No. 40 may not be totally safe, tests indicate that it does not cause extreme fetal abnormalities as does Red No. 2.

But the red peril is not completely gone; the issue is now due for a session in the courts. And the F.D.A.'s ruling allows manufacturers to use the Red No. 2 they have on hand ready for use, and does not require recall or labeling of already manufactured items containing the dye. So for some time to come, consumers still won't be able to avoid the red dye, even if they want to. — *S.J.N.*

Disease in Bacon's Cure?

Red Dye No. 2 was dropped from the F.D.A.'s approved list because of evidence that it may cause cancer (*see above*). But Red No. 2 is only one entry on an entire menu of food additives called into question recently, and not all of the chemicals used in foods present such relatively clear-cut cases. In the case of sodium nitrate and sodium nitrite, Americans may have to choose between the devil and the deep red bacon.

Sodium nitrate and nitrite carry a double whammy. First, they cause a blood malfunction called methemoglobinemia, in which the hemoglobin of the blood is chemically immobilized and cannot carry oxygen. In the amounts allowed by the F.D.A. — up to 20 milligrams per quarter pound of cured meat — a significant percentage of the blood of an adult can be affected — 5 per cent of the blood can be temporarily unable to carry oxygen. If more nitrite were to be consumed accidentally, if the food was improperly treated with too much sodium nitrite, or if the victim was anemic and could not do without even that amount of active hemoglobin, illness would be likely. Infants are particularly susceptible to this disease, and the use of sodium nitrite in baby foods has been discontinued by some large baby-food manufacturers.

Whammy number two: nitrites tend to combine with amines, in the presence of acid (even stomach acid will do) to form nitrosamines, a potent carcinogen.

Nitrites are not uniquely man-made, but flourish in our food environment. They've found in small quantities in root and leafy vegetables, such as beets and spinach. But in the food industry they are added to meats and fish both to cure the product and to lend a permanent distinctive red cast to bacon, lox, and other smoked fish and sausages.

Amines abound in wine, tea, and in over-the-counter and prescription drugs, such as antihistamines. The combination of nitrites and amines, nitrosamines, has caused cancer in laboratory tests on rats, dogs, monkeys, and guinea pigs. There is no indication that the human animal should alone be immune. In addition, nitrosamines attack any area of the body they come into contact with. Most carcinogens are much more cell-specific.

Food industry spokesmen argue that the sodium nitrite and nitrate are essential to prevent the growth of deadly botulism spores in their products. Saltpeter, or potassium nitrate, has been used to cure meats since Roman times, they point out. While meat and fish processors have the technology to avoid the use of nitrites and nitrates altogether, they would rather not rely, they say, on the sometimes faulty refrigeration of shippers and retailers. Besides, one death from a processing-induced botulism can destroy a company. No one has forgotten the sad case of Bon Vivant, the canners who were forced out of business after a botulism scare in the 1960s.

Consumer advocates reject the food-preservation argument for nitrates. Health food stores have been selling nitrite-free bacon for years, and its consumers have never encountered botulism in the products, they point out. They believe that the processor is really more interested in the convenience and lowered costs of shorter processing time than concerned for the consumer. And, say consumer advocates, the customer has been led to expect that bacon and sausage be red: market acceptance of the grayish-brown of non-treated products would mean a costly consumer education campaign, which the industry would rather avoid.

While the debate over nitrates is far from settled, some facts have been established. One group of South Africans, who drink a locally distilled alcoholic beverage high in nitrites, experiences a markedly higher incidence of esophageal cancer than other groups in the same area. Another population in Colombia, whose drinking water is high in nitrates, show higher incidences of gastric cancer. But scientific research moves slowly, and nutritionists hesitate to claim a cause-effect relationship between nitrites and cancer in these cases.

While scientists have established that nitrites can and do combine in the stomach and form nitrosamines, the rate and circumstances which govern their formation remain unknown, as do the chemicals' actions once they appear. For example, vitamin C seems to retard the rate of nitrosamine formation. Further research is necessary, they claim. Nevertheless, some nutritionists have concluded that the sodium nitrite situation clearly constitutes a potential carcinogenic risk of considerable magnitude. — *S.J.N.*

FUEL

Nuclear Power and the Straitjacketed State

The Massachusetts Commission on Nuclear Safety cautiously approved nuclear power for the Commonwealth, with some stipulations:

Train the state police to treat radiation exposure. Train state officials in evacuation procedures. Make nuclear power plants liable for decontamination and restoration necessary following a power plant accident. Provide armed escorts for shipments of plutonium or enriched uranium through the state, if the federal government fails to take on this job.

These and other recommendations — which, if implemented, would necessitate an unrelenting vigilance on the part of the state — make clear the vacuum in which states must operate if they seek to regulate nuclear power. The federal government has jurisdiction over nuclear power and materials when any matter of health or safety is involved; the state is reduced to releasing an army of workers to hover around the radioactive queen bee, if only to prove to themselves that she is working harmlessly.

The commission was appointed in 1974 by Massachusetts Governor Francis Sargent to study the role of the state in assuring the safety of nuclear power plants. The 11 scientists, educators, and public officials on the commission released their report last September.

Regardless of the state's conclusions about the safety of nuclear power plants located within its boundaries, the state has little power over the transport of nuclear materials related to those plants, power plant siting, construction, or the like — and what's left after these general categories wouldn't fill a thimble.

George Rathjens, Professor of Political Science at M.I.T., commission head, left the feeling that his commission could do little more than share its fears with the state, though its suggestions are in fact being used in state policy-making. The commission did no original research; there was neither time nor money to do it and no power to activate change had anything new been discovered.

Thus the commission relied heavily on the WASH 1400 report (produced by a team headed by Professor Norman Rasmussen of M.I.T. last year) and on a more recent analysis by the American Physical Society. The commission's *de facto* analyses of these reports will serve the nuclear debate up in a style the state legislators can swallow, if nothing else.

The commission "came away very relaxed about routine emissions," said Dr.

Rathjens. The radiation absorbed by anyone living relatively near a nuclear power plant was found to be less than the amount absorbed by the average person from medical or dental x-rays yearly, and the commission finds no fault with this data. Even boiling water reactors, which try to prevent radiation release by holding radioactive gases in storage for only 30 minutes, do not disturb Dr. Rathjens. The cost to retrofit such plants to allow them to hold these gases until their radioactive level subsides "seems like a foolish way to spend money compared to other social demands. If it enhances the image of nuclear power plants and makes the public happy, OK, but it's crazy," he said.

But the commission felt strongly that WASH 1400 makes too light of the damage which would come from an accident in a power plant. They fear that a meltdown in a plant on the ocean, considering the population density and the prevailing winds, could be disastrous. "Perhaps a less hazardous means of energy will be developed in the next few years," Dr. Rathjens offered. On accidents, the commission said, "We are, in summary, troubled."

Of most concern was the possibility of sabotage — "plant protection measures are not sufficient," Dr. Rathjens said. "Things have improved enormously over the last year," he admitted, but while the likelihood of sabotage by one or two disgruntled employees has decreased, the plants are as susceptible as ever to wholesale attack by terrorists.

Sad news for a state whose powers are limited by the federal government to placing liability and enforcing such other federal regulations as effluent control and reasonableness of location. As on the Animal Farm, everything that is not required is forbidden. — *S.J.N.*

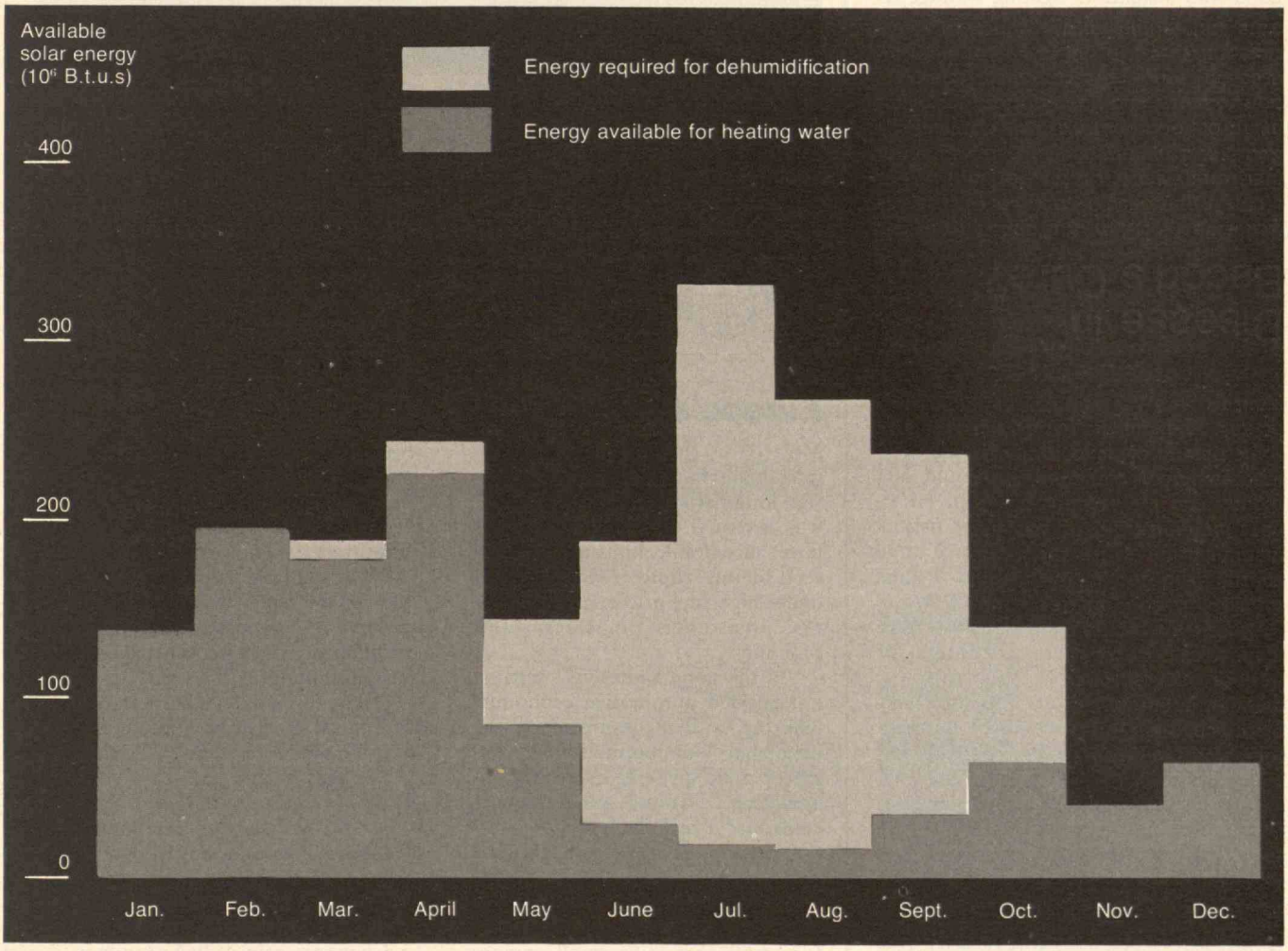
Solar Yields to Its High Capital Cost

A solar-powered dehumidification system — proposed to be part of the air conditioning system for the new Citicorp Center in New York — "is technically feasible with currently available equipment operating within its known performance range." But it will not be built.

The projected annual savings of the solar-powered part of the air conditioning system are less than 2 per cent of the capital cost, says a report from the M.I.T. Energy Laboratory. The solar savings potential is significantly reduced by Citicorp's adoption of a number of energy-saving options for the building's conventional air conditioning system. And that makes "free" energy from the sun-powered system too expensive. Its design and analysis were commissioned from M.I.T. by the National Science Foundation, which hoped to demonstrate a new form of energy conservation for high-rise buildings.

The solar dehumidification plan for the Citicorp Center which Dr. Leon R. Glicksman and his colleagues at M.I.T. analyzed was based on use of a chemical desiccant — instead of conventional chilling — to dehumidify air for the top 25 floors of the building. Heat from a solar collector on the roof would dry the desiccant for reuse. In all but the most muggy summer months, there would be surplus solar-generated heat for hot water service in the building.

M.I.T. studies showed that the solar



A solar energy plant atop the Citicorp Center in New York would collect 2.3 billion B.t.u.s of heat a year, most of it to be used during the summer months by a dehumidifying system. But according to M.I.T. estimates the solar-powered system would cost just over $1.7 million, and its annual saving over conventional energy would amount to about 1 per cent of that amount. This return on capital is too small, and the solar system will not be built.

system would save $20,000 a year on operating and maintenance costs; its total capital cost $1.7275 million. On the basis of weather data for 1968, the solar system on the roof of the Citicorp Center would collect 2.3×10^9 B.t.u.s of heat, plenty to do the assigned job — but at a capital cost which Citicorp and M.I.T. agree is too high.

Three factors made this example a severe test for solar energy:

— The Manhattan location assures construction costs well above the national average; Dr. Glicksman adjusted the "handbook" cost figures for the solar energy installation upward by 1.22 for labor and 1.11 for materials to account for the New York location.

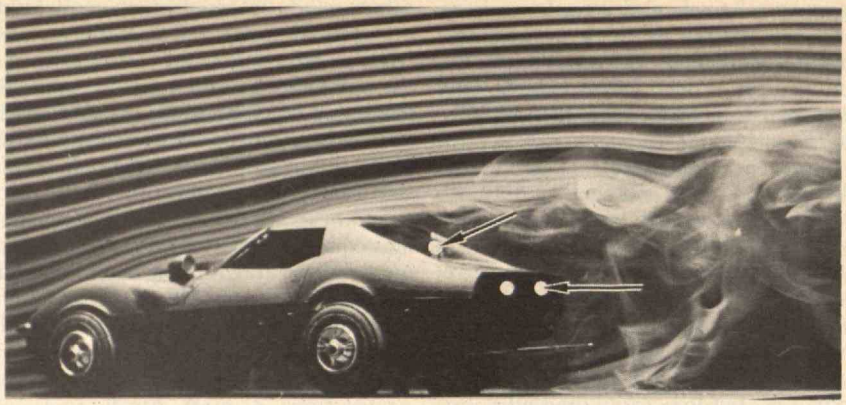
— The system had to be designed at M.I.T. to fit a structure whose basic design was complete and on which construction was in fact in progress. Some compromises and extra costs were necessary.

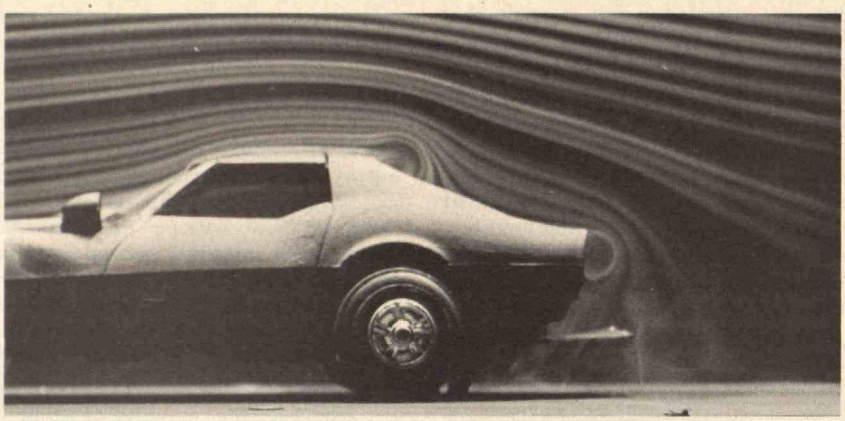
— Solar was being pitted against conventional energy in a building designed specifically to conserve energy. Only 46 per cent of the exterior surface of the Citicorp Center is to be glass, and that will be reflective double glazing. There will be good wall insulation, lighting wattage reduced about 50 per cent from recent New York practice, and heating and ventilating managed by a computer-operated building management system. Under these conditions, Dr. Glicksman points out in an interim report on the project, solar energy has the least leverage on conventional energy costs. — *J.M.*

Europe Hatches an Energy Plan

While Americans have 600-years-worth of coal to fall back on in their energy crisis, Europeans are almost desperately at the mercy of the Arab oil sheiks. All their oil is imported and coal reserves would last only a few decades if leaned on. Hence Europe's enthusiasm for nuclear fission. Nuclear fission could be the source of all primary energy for Europe and Britain, including electricity and hydrogen as secondary fuels, according to analyst Wolf Hafele at the International Institute for Applied Systems Analysis in Geneva.

Fast-breeder and high-temperature reactors, now in various stages of development, are the basic components of Dr. Hafele's vision. The fast-breeder reactors, besides generating electricity, would produce plutonium to fuel additional breeders and to convert the abundant isotope thorium (^{232}T) into uranium (^{233}U). High-temperature gas-cooled reactors fueled with uranium, besides generating more electricity, would yield high-temperature heat to produce hydrogen from methane, via the heat-driven chemical reaction: $CH_4 + H_2O \rightarrow 3H_2 + CO$. Consumers receiving this hydrogen-carbon monoxide





A good aerodynamic line might save 6 to 8 per cent of an automobile's fuel consumption. The European automakers problem is to eliminate "pressure drag," caused when the air flow separates into turbulence from the rear of the vehicle. A good example is a wind tunnel test of a model of a Corvette made at Lockheed Georgia Co.: stabilize the air flow by "locking" in place behind the vehicle small permanent vortices. This is accomplished by adding suction — calculated to be about 60 cubic feet per second in the case of a full-size automobile proceeding at about 60 miles an hour — at three points shown by the arrows. The result in the wind tunnel is the stabilized air flow and markedly decreased drag shown above.

Europe's Future Car

Most of us think Europeans mastered high-efficiency automobile design long before the "energy crisis" was invented. But even the European automobile industry finds itself facing rapid readjustments under high fuel prices and consumers' insistence on safety and economy.

"In the good old days," says an unidentified automotive economist working for the Commission of the European Communities, "an engineer could give free rein to his imagination." Today car designers confront "a real challenge."

Europe's "car of the future" could have:

— Front-wheel drive. Forward-drive has been impractical except for small cars with small engines placing a minimum load on the front suspension. New, light alloys will alleviate the constraints of engine weight. Thus the advantages of better roadholding, greater safety, and low cost will be realized by more European automakers.

— Better aerodynamics. "The car of tomorrow is likely to come to a point at the front and slope slightly toward the rear," writes the C.E.C. observer. "A good aerodynamic line could mean 6 to 8 per cent saving in fuel consumption."

— New, lighter weight materials. Structural analysis by computer will help designers trim weight without reducing strength, and new materials — light alloys and rust-resistant steel plate — will be used. It takes 6.7 times as much energy to make aluminum as to make an equivalent weight of steel, but a 10-per-cent weight reduction means a 5-per-cent gain in fuel economy.

— New components. More efficient automatic transmissions and computer-controlled carburetion and ignition are mentioned. — *J.M.*

mixture in their pipelines would, in effect, run the reaction in the other direction by burning the gas.

This proposal, says Dr. Hafele, represents "a radically different use of the virtues of fast breeders" — utilizing process heat as well as fuel redoubling. It uses technology that is "basically available today"; and it eliminates dependence on fossil fuel by replacing petroleum with reactor-based energy comparable in cost to oil at $12 per barrel. — *J.M.*

Capturing the Sun in Puddles

When spring finally comes and the ice cover melts, the shallow ponds of New England warm so quickly that swimming is sometimes appealing by April — a tribute to the power of the returning sun even in mid-northern latitudes. The same simple idea is now being developed to heat process water for a new Sohio Petroleum Co. uranium refinery near Albuquerque, N.M.; it will be one of the nation's first major industrial users of solar energy.

A chemical leaching process using dilute hot acid is to be used by Sohio to concentrate uranium ore to uranium oxide. The requirement is for 720,000 gallons of hot water (140° F.) every 24 hours, requiring about 175×10^9 B.t.u. annually.

According to plans developed by Lawrence Livermore Laboratory of the University of California, half this energy will come from six acres of "solar ponds" — plastic bags through which water from five to ten centimeters deep will be continuously circulated. Under the bags will be sheets of black plastic and layers of insulation; above, layers of clear plastic to minimize radiation loss.

(A different "solar pond" concept is proposed by Professor Carl E. Nielsen of Ohio State University: a pond several meters deep would have salty water at the bottom, pure water above. The sun would heat the salty water — even heated, it is too heavy to rise to the surface where the heat would dissipate — to temperatures as high as 170° to 190° F., and the heat would stay there, insulated by the fresh water above, until extracted through a heat exchanger in the bottom of the pond.)

In Sohio's simple, shallow ponds, circulating water will reach 75° F. in January and 130° F. in June, and the solar energy will contribute between 20 (January) and 90 (June) per cent of the heat needed to warm the plant's process water — a year-round average of 55 per cent, a saving of about $300,000 in oil at $14.70 per barrel. If the solar pond system lasts 15 years and if Sohio wants a 15-per-cent return on its solar investment, the solar pond system has to cost no more than $40.35 per square meter; the estimate is $24.09.

Solar pond collection efficiency falls sharply if the water in such a simple, shallow pond is to be heated to over 140° or 150° F. That's well below present practice in most industrial water heating plants. Hence the question: how many processes can efficiently use 140° water? No one knows, and the Energy Research and Development Administration (E.R.D.A. and Sohio are jointly sponsoring Lawrence Livermore's design work) is now surveying industrial process heat uses to find out. W. C. Dickinson, Solar Projects Leader at Lawrence Livermore Laboratory, believes the answer will be "a significant fraction," and he proposes that simple, shallow solar ponds represent "the lowest cost method available for using solar energy to produce hot water in large volumes." — *J.M.*

Promise of Fuel in Methanol

When gasoline grows scarce, can the U.S. run its automobiles on methanol?

Probably. Recent research suggests that an automobile engine especially designed to burn methanol might be both more efficient and less polluting than today's gasoline-fueled engines.

Most of the advantages of methanol as a motor fuel result from the fact that it can be burned in "leaner" mixtures — more air and less fuel — than gasoline. As oxygen to the engine is increased, increasing fractions of the hydrocarbon and carbon monoxide combustion products are converted to water and carbon dioxide; and nitrogen oxide pollutants are also reduced because peak combustion temperatures are lower.

The addition of water (5 to 10 per cent by volume) increases the octane rating of methanol. Though a "lean-burn" engine has somewhat less power than today's typical engine, a higher-octane fuel would make possible very-high-compression engines in which efficiency can be high and power output somewhat improved.

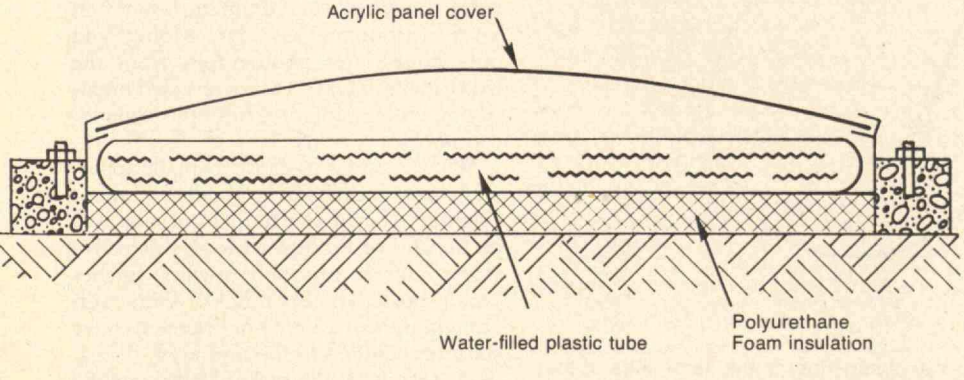
Their study of methanol in a single-cylinder test engine has convinced W. J. Most and John P. Longwell of Exxon Research and Engineering Co. that methanol could result in "substantial improvements in end-use energy efficiency and reduction in NO_x and CO pollution."

Problems remain, and Drs. Most and Longwell do not propose methanol as a fuel for today's automobiles. Among unresolved issues:

— Under lean combustion, peak power would be inadequate for rapid acceleration. A variable air-fuel-ratio carburetor would be required.

— Gasoline contains many fractions of hydrocarbons, but methanol is a single-boiling-point material. Different carburetion would be required, and cold starting and vapor lock are considered "potential problem areas."

But "no problems have been identified which are outside the scope of existing engineering practice and technology," Drs. Most and Longwell write in a paper for the 1975 Engineering Congress of the Society of Automotive Engineers. — *J.M.*



The flat, water-filled plastic tube at the solar pond is 10 centimeters high, 3.5 meters wide, and 60 meters long; sitting under the hot New Mexican sun, the 20 cubic meters of water it holds will warm to at least 150° F.

Such a solar pond is thought by engineers at Lawrence Livermore Laboratory to be the least expensive system now available for converting solar energy into heated water.

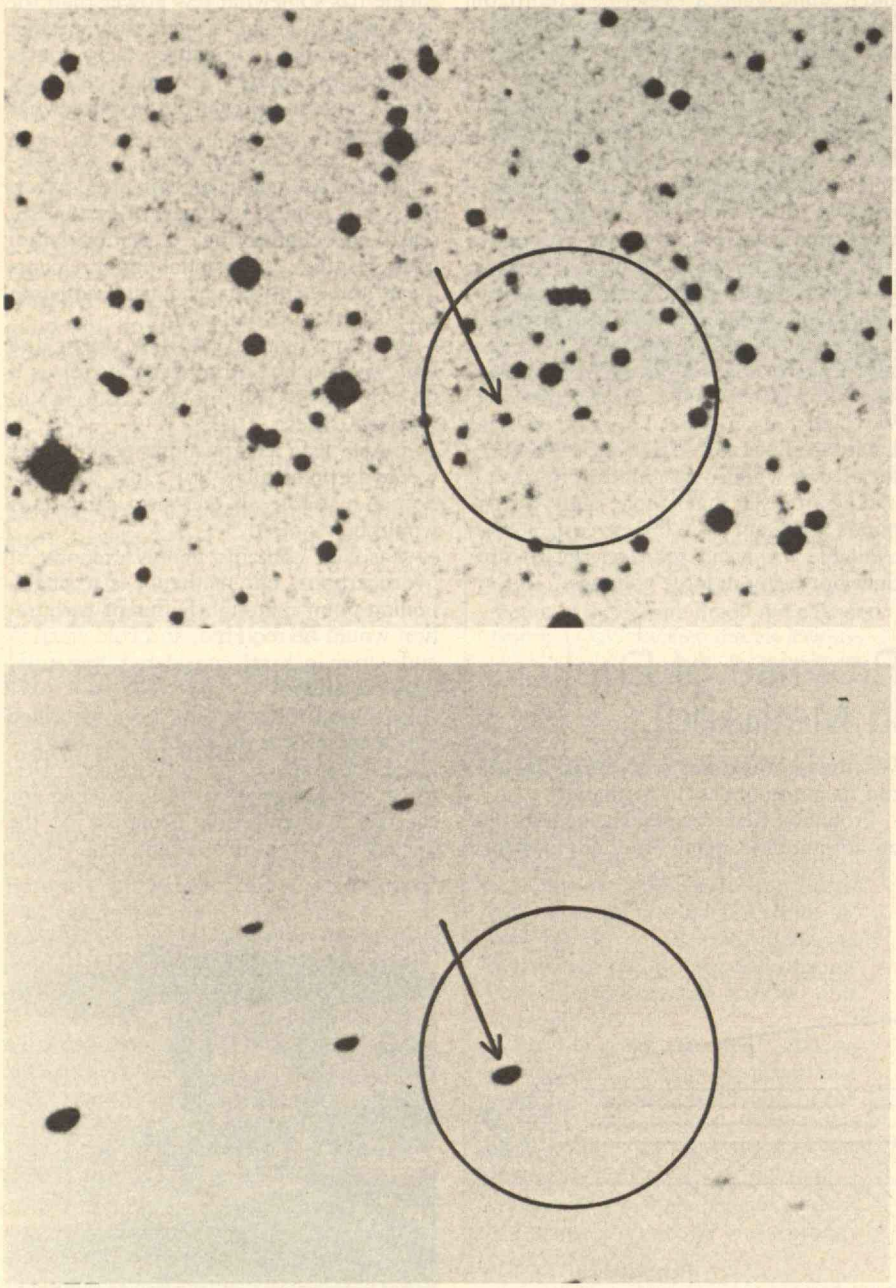
X-Ray Nova: An Unsolved Who-Done-It

The world's most sophisticated orbiting x-ray observatory was launched aboard SAS-3 — N.A.S.A.'s third Small Astronomy Satellite — in May, 1975. A few days later, the first observations were made by the new McGraw-Hill Observatory on Kitt Peak, Arizona. Less than two weeks later the two were teamed, as their planners had proposed, to provide a multi-media view of the sky in x-ray and optical wavelengths.

The most spectacular achievement has come through the discovery of a new source of x-ray radiation five times more intense than ever before recorded.

Only late last fall, as this remarkable x-ray source in Monoceros near Orion — A0620-00, it's called — was beginning to dim, could astronomers take time for a formal dedication ceremony for the McGraw-Hill Observatory. By then it was clear that the Observatory and SAS-3 had together figured in a major astronomical discovery.

The newly discovered nova represents "a whale of a lot of energy," says Delo E. Mook of Dartmouth College — a sudden flaring equivalent to "at least 10,000 suns being turned on, perhaps more." A similar event on the sun would spell instant catastrophe to the earth. The discovery and analysis of A0620-00 are the first chapters of a detective story, says Professor Mook, "but we haven't quite cracked the case yet."



A plate made at the Mount Palomar Observatory (top) in 1955 shows A0620-00 as an inconspicuous star in Monoceros, near Orion. Seeking the sources of an outburst of x-ray radiation last summer, astronomers at the McGraw-Hill Observatory were led by the orbiting SAS-3 x-ray observatory to the same area of the sky; in a new photograph (bottom) they found A0620-00 "in an explosive state at least 300 times brighter than in 1955." A neutron-star pair acting as a "recurrent nova," postulates Professor Saul A. Rappaport of M.I.T.

"A Star's Lifestyle"

The idea for the observatory at Kitt Peak began with Dr. Mook in 1974. He and his associates at Dartmouth had been collaborating with scientists at the University of Michigan and at M.I.T. on x-ray astronomy, and they realized that to exploit fully the capabilities of SAS-3, optical observations should be coordinated with the x-ray studies.

To use the 52-inch telescope near the University of Michigan at Ann Arbor was impractical: sky brightness near Ann Arbor was increasing, and there was good weather only about 30 nights a year. Why not move it to Kitt Peak, the site of the Kitt Peak National Observatory, proposed Dr. Mook.

"A very long shot," thought Leonard M. Rieser, Dean of the Faculty of Arts and Sciences at Dartmouth, when he heard the plan. But McGraw-Hill, Inc., and the Alfred P. Sloan Foundation were intrigued, and in six months, beginning in November, 1974, the McGraw-Hill Observatory was created on a brushy hillside overlooking Tucson.

A0620-00 made its presence known on August 3, when the British Ariel-5 satellite detected a new source of x-ray radiation. By August 15 the more sophisticated equipment on SAS-3 had pinpointed the source of the radiation — by now very intense, "a very, very dramatic event" in x-ray astronomy, says Dr. Mook; and only hours later photographs from the McGraw-Hill Observatory revealed intensifying visible radiation from the same location.

What happens to cause a small, apparently insignificant star to suddenly flare so brightly? The answer to that question will be the end of Professor Mook's detective story, and it probably awaits further "multi-media" observations of x-ray radiation in the universe. Other elements have since been added to the mystery:

— A search of Harvard University astronomical records suggested by Saul A. Rappaport, Associate Professor of Physics at M.I.T., showed that A0620-00 had flared in much the same way in 1917 — but nobody had noticed.

— A new nova — unprecedented in its rapid rise in brightness — appeared late in August in the constellation Cygnus. But this one, like most novae, emits almost no x-ray energy. A0620-00 emits 1,000 times more x-ray than optical energy — "very surprising," Hale V. Bradt, Professor of Physics at M.I.T., told the McGraw-Hill dedication.

— A spectrograph designed by M.I.T. for use with the McGraw-Hill Observatory showed that the light of A0620-00 covered the whole visible spectrum — no absorption lines such as stellar spectra usually show. When he made this observation, Forrest I. Boley, Chairman of Dartmouth's Physics and Astronomy Department, was mystified. "We're looking at an unusual thing," he said, ". . . something of incredible heat intensity. . . . A star of some kind that we have not yet been able to model has in some way changed its mode of life . . ."

Seeing Better with Two Eyes

Professor Rappaport was the first to suggest that A0620-00 might be a "recurrent nova," in reality two stars in close orbit — one an ordinary star and one a highly condensed, extremely compact nucleus — a "white dwarf," perhaps even a "neutron star." As gravity pulls matter from the regular to the condensed star, density and heat build up toward an explosion. Then the system cools, and the process begins all over again. The presence of x-rays suggests to Professor Rappaport that A0620-00's compact star is in fact a "neutron star," denser and even more energetic than a "white dwarf."

The point of all this, reported in a symposium on x-ray astronomy dedicating the McGraw-Hill Observatory, is to emphasize that new Observatory's special value to astronomy. It is the first optical instrument devoted full-time to studying sources of x-ray emissions, providing a new perspective to this fastest-growing branch of astronomy. "Seeing with two eyes is better than one," said Professor W. A. Hiltner of the University of Michigan at the dedication ceremonies; "the whole picture becomes much, much clearer." — *J.M.*

"Black Hole" Found?

A puzzling new result from SAS-3 (*see opposite*): intense bursts of x-rays are coming constantly from a spot somewhere in the constellation Sagitarius, near the center of our galaxy.

The bursts flare up in less than half a second; they die down in ten seconds; and they recur on the average every 15,718 seconds — about once every four and a half hours. But the periodicity is not precisely constant at 15,718 seconds; there is what Professor George W. Clark of M.I.T. calls a " 'phase jitter' of about 500 seconds one way or the other; the longest has been 1,000 seconds."

This result by Jesse G. Jernigan, Jr., an M.I.T. graduate student, and a similar finding by Herbert Gursky and Jonathan Grindlay of the Center for Astrophysics in Cambridge, were the chief topic of corridor conversation at the mid-winter meeting of the High-Energy Astrophysics Division of the American Astronomical Society at M.I.T. in January.

No wonder: it is "the first direct evidence for the presence of a really massive 'black hole,' " said Dr. Gursky . . . "one of the most exciting new results in x-ray astronomy," Dr. Grindlay told Robert Cooke of the *Boston Globe*.

Their explanation: astronomers theorize that there should be a "black hole" in the center of any cluster where the density of stars is so high that there must be many collisions — a globular cluster. The stars fall together and build up an immense mass in the center, where gravity is so great that even light cannot escape — hence the term "black hole."

Such an immensely heavy collapsed body would have to be surrounded by an extremely hot cloud. The x-ray pulses observed from Sagittarius fit exactly the pattern of very fast pulses modified by such a hot cloud — building up in half a second, decaying during ten seconds.

But Professor Clark was intrigued by the "phase jitter," not involved in the previous explanation, and by the large difference between the duration of the x-ray burst (ten seconds) and the interval between bursts (15,718 seconds) — a difference unheard of before in x-ray astronomy. — *J.M.*

A closer look at Mars has revealed a rugged terrain dotted with extremely high mountains. The Tharsis Mountains, located near Mars' equator, rise at least 30 kilometers above "sea level," and are the location of a major gravitational discontinuity, according to three M.I.T. scientists. (Photo: NOVA)

Mars: High Mountains and High Gravity

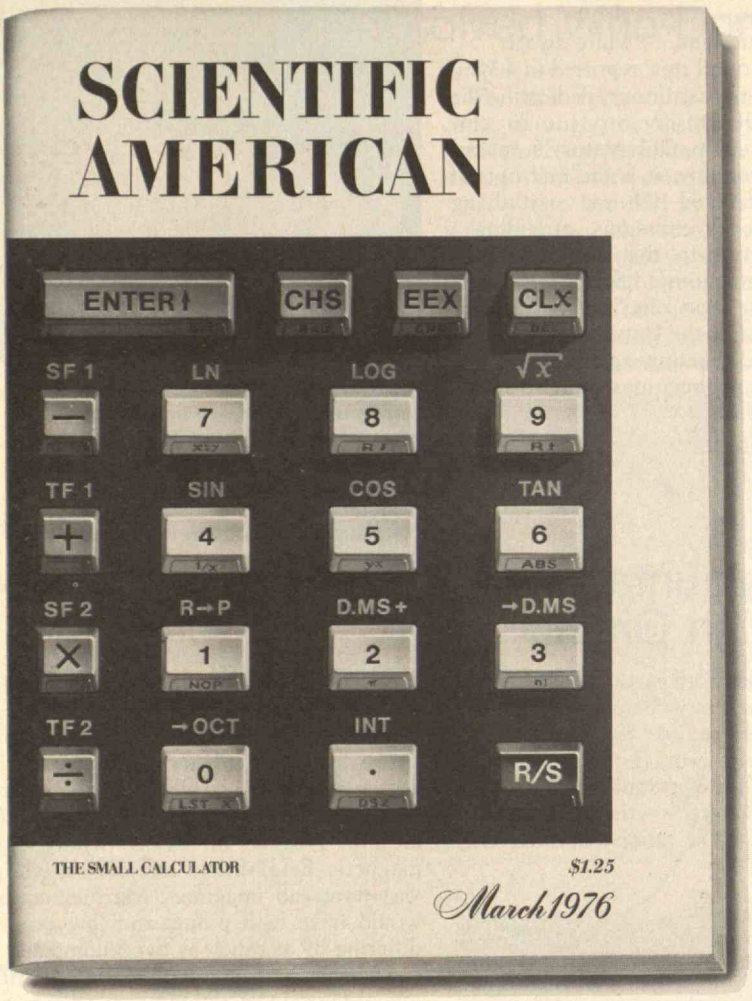
We know from both earth and moon that gravity is not everywhere constant on a planetary surface; for example, the astronauts' orbits around the moon wobbled due to the gravitational variations caused by mascons — the large metallic deposits below the moon's surface. One way to express these gravitational anomalies is by their power — real or theoretical — to displace sea level from a perfect ellipsoid.

The gravitational anomalies on earth are very slight; sea level varies from a perfect sphere by no more than about 50 meters. Not so on Mars, where the magnetic field shows remarkably wide variations: an imaginary Martian ocean would have high points and low points differing by as much as two kilometers.

Changes in the speed of Mariner 9 during its Martian encounter, measured from earth in Doppler tracking data, have now been transformed by Robert D. Reasenberg and his associates in the M.I.T. Department of Earth and Planetary Sciences into the most accurate description yet available on Mars' gravity field.

Knowledge of the gravitational potential of any planet provides strong constraints on models of its interior — and hence on our understanding of the mechanisms by which it was created. An example from the recent work reported by Dr. Reasenberg (with Professor Irwin I. Shapiro and R. D. White of M.I.T.): a major Martian gravity discontinuity is associated with the Tharsis Mountains, which rise near the Martian equator to a height of nearly 30 kilometers. No such discontinuities are found with mountains on earth, because the Alps and Himalayas float in the earth like icebergs, with masses below the surface compensating for those above.

But the Tharsis Mountains are hypothesized to sit on the Martian surface with no compensating "roots" — an observation which Dr. Reasenberg and his colleagues find "consistent with the assertion that the lithosphere must be thick (perhaps 200 kilometers, in contrast to the earth's 30 kilometers) and rigid." — J.M.



From the twinkle in its eye, to the clock in its heart

...an intimate look at small electronic calculators.

The cover story of the March issue of SCIENTIFIC AMERICAN takes you inside a typical small electronic calculator. While it is well known that the hand calculator's working turns on a tiny microelectronic "chip," few realize that the chip contains the major elements of a big computer —a central processor and an active memory. And what about the twinkle (that lights the light-emitting diodes) and the read-only memories called in by the function keys and the 250-kHz main clock (12,000 clock cycles for a simple instant addition)?

"For millions of people," says Eugene W. McWhorter, computer engineer and author of the article, "arithmetic will never be the same again."

For the regular readers of SCIENTIFIC AMERICAN, McWhorter supplies the latest installment in a continued story. Starting with "The Transistor" in 1948, we have informed our readers step-by-step of the advances in hardware and software that have culminated in this hand-held revolution.

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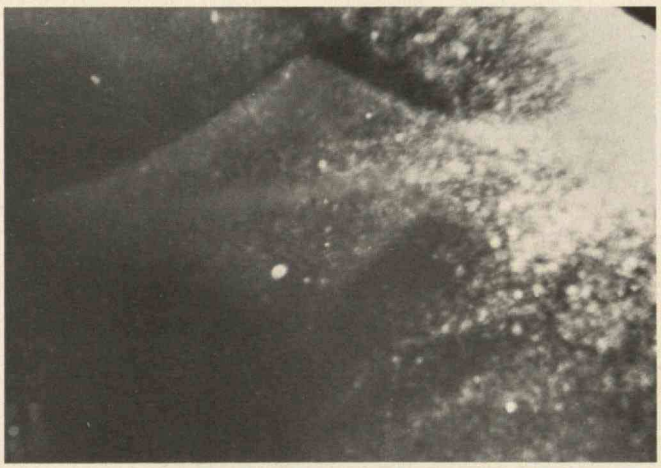
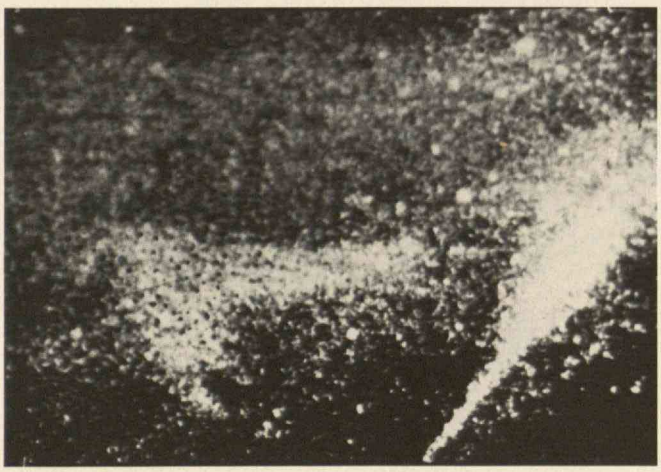
Search for the Loch Ness Monster

Photographs and sonar records obtained at Loch Ness, Scotland, in 1972 and 1975 provide additional evidence for a species of large aquatic creature — the "Loch Ness Monster" — inhabiting the loch.





The first underwater photographs of the "Loch Ness Monster" were these famous shots (shown computer-enhanced and duplicated with higher-than-normal photographic contrast) obtained by Dr. Rines and his colleagues in 1972. They offered tantalizing clues to an age-old mystery, which was heightened even further by the new photographs obtained in 1975. The above photographs are the famed "flipper" pictures, the second taken 45 seconds after the first. The difference in position of the flipper indicates movement. Measurements from these photographs indicate the flipper is about four to six feet long, which agrees well with measurements from sonar records obtained during the same period. The picture at the left is the 1972 "two-body" photograph, taken when the sonar record indicated the presence of two large objects. Their lengths and separation agree well with the sonar record. (Academy of Applied Science)

Above: Urquhart Bay in Loch Ness. The Enrick and Coiltie Rivers empty into the Bay from the right of the picture. The ruins of an abandoned castle stand on the promontory. Right: A three-dimensional map of Urquhart Bay, showing deep channels which the camera-strobe and sonar apparatus monitored in the 1972 and 1975 Academy of Applied Science Expeditions. The depth dimension is expanded to better show the contours. The Academy investigators reasoned that a fish-eating creature might lay in these valleys awaiting salmon swimming into rivers from the bay. (Copyright: Academy of Applied Science)

Loch Ness in northern Scotland is the largest freshwater lake in volume in Great Britain, and the third largest in Europe. Although it is only about 24 miles long and a mile or so wide, it more than compensates for this small surface area with its remarkable depth, a maximum reported at 975 feet, and 700 feet over much of its length. The sides of the loch slope downward precipitously away from the banks, and the bottom has been shown to be mainly a flat, vegetation-free plain of silt. Salmon, sea trout and elvers migrate from the sea into the loch and from there up several rivers running into it. There are resident populations of brown trout, eels, char, and stickleback, and the shallows harbor profusions of freshwater weeds. The waters of the loch are cold — at a fairly constant year-round temperature of about 42° F. — and extremely murky, due to the large amounts of suspended peat particles. Maximum underwater visibility is limited to a few feet.

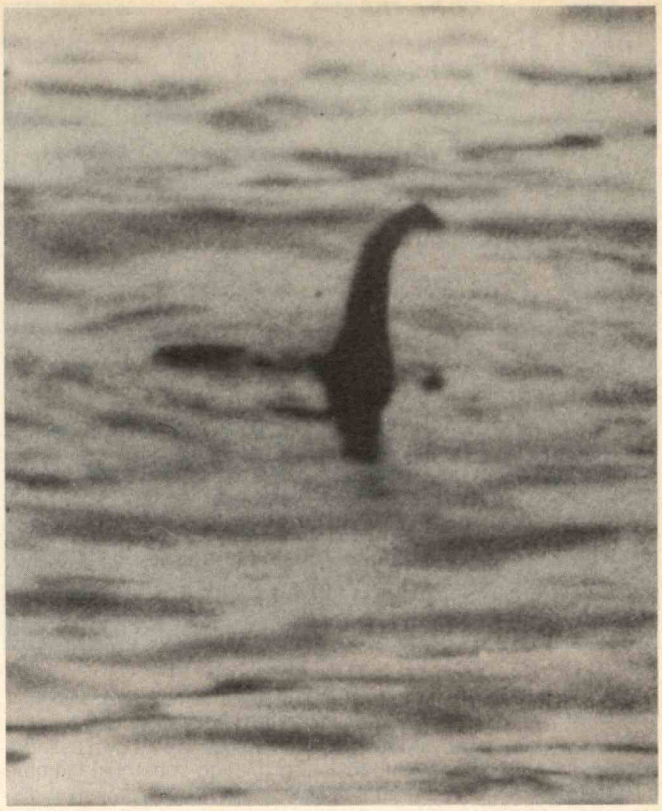
Even before the Highlands of Scotland were introduced to the outside world at the beginning of the Middle Ages, there were legends of large aquatic creatures in the lochs. The legend of the water horse or kelpie was widely believed, and still persists today. This creature was said to occupy lonely lochs and to lure weary travelers to their death. The first record of a large creature in Loch Ness was in 565 A.D. when Saint Columba, the man who brought the Christian religion to Scotland, was said to have encountered a large monster in the loch and frightened it off. Similar sketchy accounts of monsters, "floating islands," and "Leviathan creatures" appeared occasionally in journals and other records.

News of a monster in the loch was first widely disseminated in 1933 with the publication of several newspaper stories following completion of an auto roadway along the western shore. Since then the monster has been a more or less regular phenomenon, with literally hundreds of reputable sightings by laymen and scientists alike. Over the 50 years or so of modern sightings, descriptions of the monster have remained consistent. The creature is usually said to total about 20 feet long and possess one or two humps and a long, slender neck topped by a small head. Several observers have reported protruberances from the head, which has been described as bony and angular. The humps project several feet out of the water. The creature swims rapidly, submerges and surfaces creating a definite wake as it moves. It swims both with and against prevailing winds. The color has been consistently described as dark gray or brownish black, although some observers have reported a light streak down the "belly," and others have described dark blotches or cow-like dapples. Several observers report seeing fish and birds reacting to the appearance of the object.

Verified photographs and motion pictures of the phenomenon (particularly the motion picture obtained by British aeronautical engineer Tim Dinsdale) agree well with sighting reports: they show humps, and in one case, what appears to be a slender neck and head protruding from the water (*see photo on this page*).

Since the advent of sonar, numerous records have been made by fishermen, biologists and engineers of large, moving objects traveling underwater in the loch. These objects showed up as individual, large traces, readily distinguishable from the more fragmented echoes obtained from fish schools or water bubbles.

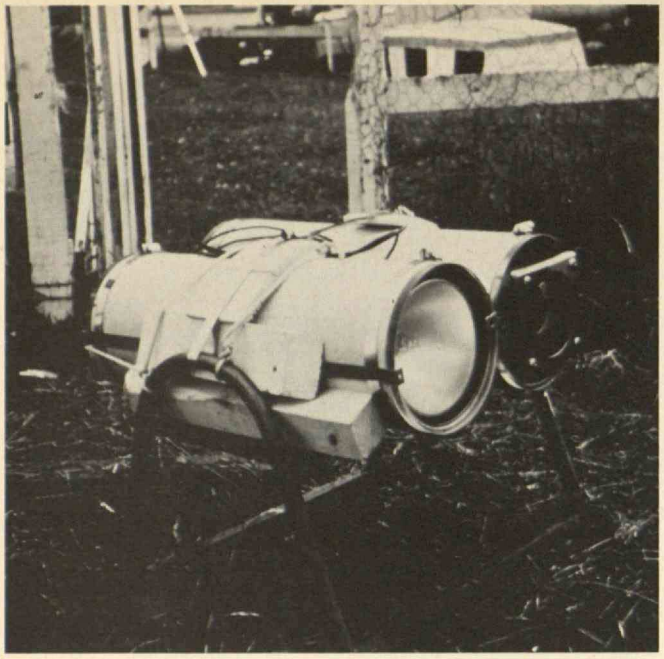
Thus, Loch Ness has a long history of reputable, consistent sightings, much of it compiled by the British Loch Ness Investigation Bureau, and modern techniques have yielded some physical evidence of large aquatic animals. It was this extensive network of circumstantial data that led the Academy of Applied Science to begin investigations in the loch in cooperation with the Bureau.

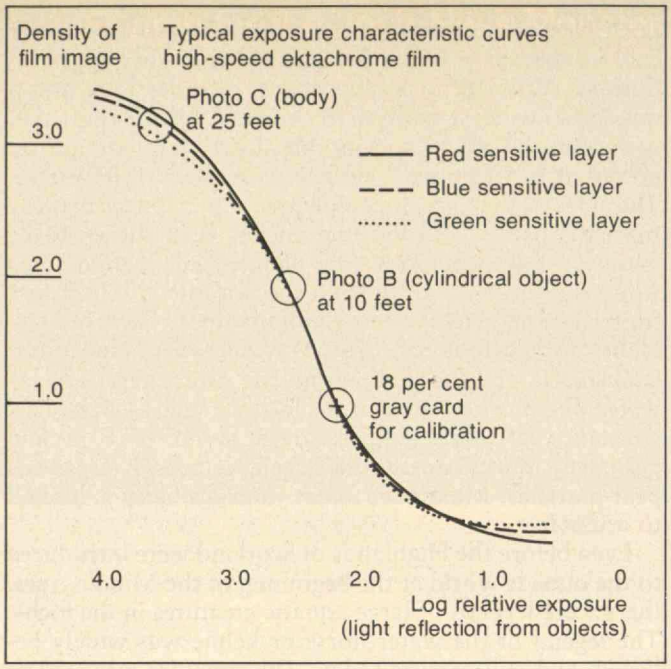


The "surgeon" photo, taken in 1934 by a London physician, is perhaps the most widely publicized photograph of the Loch Ness phenomenon. It has been alternatively explained as a bird's neck or an otter's tail, but no evidence of faking in the film negative has been discovered. This photograph is one of a pair, the second showing the object leaning "forward" as it submerges. (Associated Newspapers photograph)

The Academy, founded in 1963, consists of about 350 members, devoted to supporting unusual areas of research, and promoting interaction among scientists, inventors and industrialists.

The first Academy expedition to the loch, in 1970, attempted to confirm earlier sonar contacts with large loch creatures. Using a high-frequency, side-scan sonar designed by author Klein, several contacts were made. The most successful of these was the detection of something large passing through the sonar beam while the apparatus was attached to a pier in Urquhart Bay. About 15 minutes later, and then another ten minutes later, similar targets at further distances were detected. These objects were about 10 to 50 times larger than the fish detected many times before in the sonar beam and had a parallel-track characteristic appearance. These were definitely moving, solid objects coming in and out of the beam. The technique of using sonar to discriminate moving targets will be explained in more detail later.





Above: The camera-strobe system used in the 1972 expedition. The system consists of a 16-mm. time-lapse motion picture camera and a 50-watt-second strobe light, each housed in its own cylindrical case. Above right: A "D/logE" curve for high-speed Ektachrome tungsten-type film. Use of this characteristic curve allows the distance of a given object from the camera to be computed by the measurement of light reflected from the object. The curve is calibrated using photographs of objects at known distances. The light reflected from an unknown object can be translated into a distance measurement by referring to the curve. The points shown on the curve are for the various photographs taken in 1975 in Loch Ness. The three curves represent the light sensitivities to the three individual emulsion layers in the color film — red, green and blue.

The Camera-Strobe System

In 1972 the Academy's expedition added a camera-strobe light system developed by author Edgerton for the National Geographic Society to photograph underwater life. While Dr. Edgerton was not present at lochside, he assisted in both preparing the equipment and analyzing and critiquing the data.

The camera used in the Academy expedition consists of a 16-mm. time-lapse motion picture camera with a fixed-focus 10-mm.-focal-length lens operating at a relative aperture of f/1.8. The camera was synchronized with an electronic flash unit of about 50 watt-seconds power, and an adjustable timer capable of taking photographs from 3 to 90 seconds apart (*see above left*). With a 50-foot magazine of film in the camera, the unit can thus record 2,000 separate images over a 1¾- to 50-hour period. The camera and light were each housed in their own cylindrical, waterproof casings, and each had its own battery power source. The two were synchronized such that the strobe would flash when the camera shutter was wide open. The exposure time of the camera was .01 second and the flash duration was one millisecond. Each unit was activated by its own external switch, which was turned on just before the system was lowered into the water.

The film for the 1972 expedition was Kodachrome II, with an ASA of 25. This film allowed the system to photograph at about 10-foot distances in the water of the loch. In 1975, a better range was obtained through the use of high-speed Ektachrome tungsten-type film, with an ASA of 125. The tungsten type, or "indoor," film was used because, despite the daylight-quality of the strobe flash, the water acted as a yellow filter, which effectively "warmed" the color of the strobe flash to more nearly simulate tungsten light.

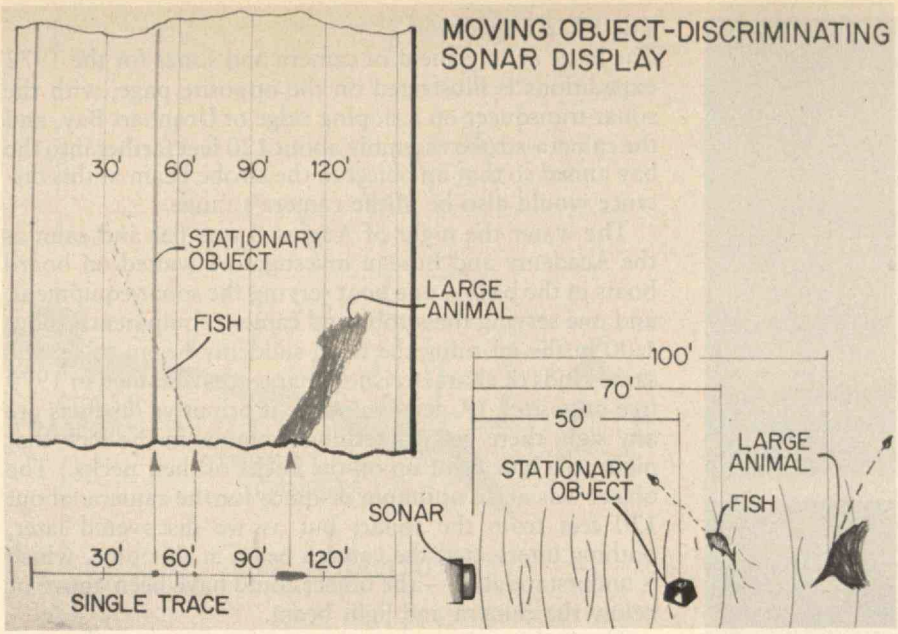
For the 1975 expedition, the previously described camera-strobe unit was used as a backup, and the primary camera was linked to the sonar system such that only the presence of a large object in the sonar beam would trigger the camera.

The peat-stained waters of the loch imposed severe constraints on the photographic system. The attenuation of light in the murky waters, in combination with the aperture of the camera lens and the speed of the film, precludes photographs at any distance greater than about 30 feet. At ranges approaching this, the resulting images are quite dark, and it should be kept in mind that the longer-distance photographs in this article have been lightened for publication.

The attenuation of light by the water did, however, have its positive side. From various calibration measurements, it was known how much optical density would be evidenced on the exposed film for a given distance of a photographed object from the camera-strobe system. To find out how far an unknown object was from the camera, one simply compared the optical density of the object with the known-distance object (*see p. 38*). From this distance information it was possible to determine the size of the object's image as measured in the frame. These measurements, it should be noted, are independent of any measurements obtained through sonar or by measuring how a photographed object intersects the cone of light emitted by the strobe. This latter method will be discussed later.

Side-Scan and Other Sonars

The sonar system used in 1970 was a Klein Associates



A moving-target-discriminating sonar trace — with the apparatus stationary — is a graph in which the vertical scale is time, and the horizontal scale distance. The straight line at the left indicates the outgoing sonar pulse. Stationary objects show up as vertical lines at various distances from the outgoing pulse, and moving objects generally show up as diagonally-oriented traces. Large moving objects will be portrayed as heavy, black traces, and small objects as lighter and sometimes discontinuous traces. (Academy of Applied Science)

HYDROSCAN side-scan sonar which used a frequency of 50 kiloHertz and a pulse length of 0.1 milliseconds, with five pulses emitted per second. In 1972 and 1975, a Raytheon Model DE 725C echo sounder was used which emitted a very short pulse at 200 kiloHertz.

Like the camera-strobe system, side-scan sonar has had an extensive history of use underwater. Usually towed behind a ship, it has been used in such applications as locating sunken ships and mapping the ocean-bottom in offshore oil exploration.

The sonar records, illustrated by the trace above, consist of a strip chart recording, in which the vertical line at the left represents the outgoing pulse, and the traces to the right, the reflections of that pulse from an object. The horizontal axis is thus distance, and the vertical axis time.

In the Loch Ness application, the aim was to detect and measure a large, moving object. So the sonar was mounted on a stationary platform placed on the sloping loch bottom, and the beam aimed horizontally out into the loch. This operating mode made the side-scan sonar a powerful tool for producing clear evidence of a moving creature, for there is no question that an object entering the stationary beam is in motion. Also, the stationary sonar obtains a long-term record of fixed objects on the loch floor — rocks, pilings, etc. These show up as straight lines on the recorder, and are recorded repeatedly. This allows any new pulses to be readily discriminated from objects already in the beam, and it can be said with certainty that the sonar is not simply reacting to background objects.

Sonar also readily discriminates between collections of small objects such as fish schools and large, solid objects. The former show up as collections of many, small tracings, as shown above, while the latter show up as solid, black tracings on the recorder. After the many hours author Klein spent monitoring the loch, and from experience in other waters of the world, he found it possible to distinguish large objects from collections of small ones. Other sonar experts were also asked to interpret the 1972 sonar traces, including Paul Skitzi of Raytheon Co.; R. Eide of Simrad Co., a sonar firm; John V. Bouyoucos of Hydroacoustics; and Ira Dyer of M.I.T.'s Department of Ocean Engineering. The actual arrangements of the camera, strobe, and sonar systems for the years 1972 and 1975 will be covered later.

Where to Look

The chances of a creature coming into camera range during the brief periods of the expeditions were quite small, considering the size of the loch and the apparent relative scarcity of sightings.

To increase the chances of observing the creature, Dr. Jan-Olaf Willums, formerly of M.I.T., performed a computer study to determine the best spot for study. Dr. Willums based his study on 258 reliable accounts of sightings between 1961 and 1970. These were collected by the Loch Ness Investigation Bureau. His correlations of the physical parameters of the sightings agree well with past experience. Eighty-four per cent of all sightings occurred during times of very calm surface conditions, and most of these sightings occurred during June, July, and August. (Of course, these results were just as likely due to visibility or to the habits of observers as to the habits of the creature.)

Seventy per cent of observers estimated the length of the object above the surface at about 20 feet or less; the mean of these measurements was 17 feet. Eighty-two per cent reported the height above the water of less than four feet. About half the observers could report a color — dark brown — and the other half reported black.

But the most important finding was that certain areas of the loch appeared far more productive than others in terms of sightings, at least on the basis of these data. Over half of the sightings occurred near river mouths and bays with active water movement, and Urquhart Bay alone was responsible for 57 of the 258 sightings. Again, this could have been because of the visibility of the bay from land or because of the habits of the observers, but at least the statistics give some idea of productive search areas. Also, corrections were made to allow for possible differ-

Calibration photographs of the bottom of Loch Ness. The top photo shows disturbed lake bottom with clouds of silt, and the bottom shot shows undisturbed bottom. (Academy of Applied Science)

ences in visibility from land of different areas. In any case, the scarcity of sightings even in productive areas helps explain why, of several hundred photographs taken, only a few produced positive results.

A three-dimensional map of Urquhart Bay was developed from bottom-sonar surveying (shown on page 26 with the depth dimension expanded) to determine the optimum placement for the equipment. It was determined that the equipment should be placed from 20 to 50 feet below the surface. The 1972 equipment was installed on an underwater ridge near Temple Pier in the Bay, aimed across a deep underwater valley. In 1975, the equipment was installed farther along the bay. We theorized that a fish-eating creature might lay in this valley awaiting salmon entering the river to spawn.

Another factor to be considered was the time of year to conduct our studies. Assuming that a large aquatic creature in the loch feeds on fish, it would be best to study the area when fish populations were high. It turns out that the bay is fed by two rivers — the Enrick and the Coiltie — and at various times of the year salmon and sea trout come into the bay to travel up these rivers to spawn. However, at certain times of the year, these rivers are dry; so we decided to wait for the coincidence of salmon spawning and dry rivers, which would cause the fish to collect in large numbers in the bay. This was the situation on August 8, 1972, when the first underwater pictures were obtained.

The 1972 Expedition

The basic arrangement of camera and sonar for the 1972 expeditions is illustrated on the opposite page, with the sonar transducer on a sloping ridge of Urquhart Bay, and the camera-strobe assembly about 120 feet farther into the bay aimed so that an object in the strobe beam at this distance would also be in the camera's range.

The water the night of August 8 was flat and calm as the Academy and Bureau investigators waited on board boats in the bay — one boat serving the sonar equipment, and one serving the strobe and camera equipment. About 1:00 in the morning the team suddenly began to see the same kinds of characteristic sonar traces obtained in 1970 (*see opposite*). (A personal note: if primitive instincts are any sign, there was something ominous in the loch that night; the hair went up on the backs of their necks.) The object was at an optimum distance for the camera, about 120 feet from the sonar; but as we discovered later, nothing intersected the camera beam at this time, which is understandable — the object could have been above or below the camera and light beam.

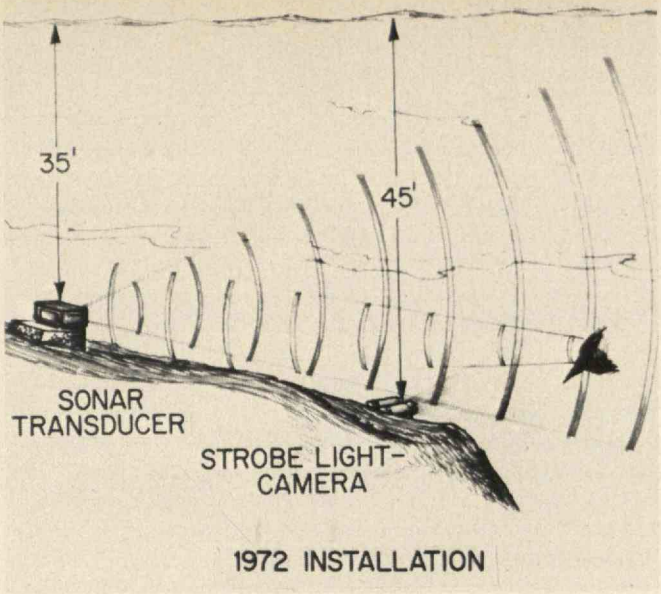
Then, about 40 minutes later, salmon were seen jumping away from something in the loch and this flight was also seen on the sonar. At the same time a large object came back into the beam, and a bit later still a second object of similar size. As you can see from the trace on the opposite page, these objects were separated by about 12 feet; they were, indeed, distinct objects. During this period photographs were obtained of what was in the beam, and these are shown on the first page of this article, in computer-enhanced versions.

The sonar chart was submitted to six experts including those named earlier, without informing them we had obtained any photographs, and they concluded that the tracings showed a large object with an approximate ten-foot "appendage," and still another large object separate from the first.

Thus, we had powerful corroborative evidence in the combination of the sonar record and the photographs and the respective dimensions available from each, particularly since we had calibrated our camera system by photographing various objects above and below the water. A typical calibration shot is shown on page 38.

Because of the murkiness of the water, the photographs obtained that night appear to be quite vague. However, when computer-enhanced, there appeared in two pictures the images of a flipper, and, in the third picture, two blobs (*see p. 25*). The flipper pictures, the second taken 45 seconds after the first, show the object in two different positions. The third picture shows what may be two bodies. It should be added that we did not recognize the existence of two bodies in the picture until the sonar experts informed us that there were two objects in the beam at about the same time. However, when the pictures were computer-enhanced, and we knew what to look for, the bodies became apparent. The relative optical measurements of this picture on the basis of densitometer measurements, confirm the sonar indication that the two objects are about 12 feet apart.

Besides the measurement from analyzing the sonar record, an independent measurement of the flipper was obtained by considering the image's size and the optical system of the camera. An inspection of the film frame showing the flipper immediately suggests that the center line of the flipper, running diagonally across the frame, is quite well in focus, whereas that portion of the image along the



Above: The arrangement of camera-strobe and sonar apparatus for the 1972 expedition to Loch Ness. At the right: The sonar trace obtained on August 9, 1972, showing two large moving objects in the beam. The faint vertical lines mark off distances of six feet. During this time period, the "flipper" photographs were obtained. Sonar experts, who were unaware of the photographs' existence, identified the lower right spike as a protruding appendage. The sonar experts concluded that two large creatures were shown half-way up in the record, separated by about 12 feet. (Academy of Applied Science)

right side of the frame is definitely out of focus. In order to appear in focus with this fixed-focus, 10-mm. lens, operating at f/1.8, the flipper cannot be closer than about four feet from the lens and would be, thus, about four to six feet long. If it were smaller and closer to the lens the image would appear to be out of focus and would very definitely be even more fuzzy than that illustrated here.

At this point we should, perhaps, say a few words about the process of computer enhancement. This technique has proven to be a reliable tool and a standard research technique in a variety of scientific disciplines. It has been used to clarify images from space probes, in forensics to help identify fingerprints, and in medical research to classify human chromosomes. In the technique, a spot of light of known and constant intensity is swept across the photographic transparency to be enhanced, usually in a raster pattern similar to that used in television. A photoelectric cell records the intensity of the light beam emerging from the other side of the transparency, and these encoded intensities are processed by the computer. The computer can be programmed to remove strong illumination gradients, that is, "smooth out" overexposed or underexposed spots, and correct other lighting artifacts in the picture. It can also increase the contrast between objects in the picture and background. The computer can make mathematical judgements only to enhance those patterns already evident on the photograph; it cannot create patterns where there are none.

The 1975 Expedition

The next successful expedition, in June, 1975, incorporated a number of new techniques into another camera-strobe system, to remedy some of the technical problems in the 1972 expedition. As noted earlier, we also switched to a more sensitive film for all photography.

The severe backscatter from the particulate matter in the water was reduced by putting about five feet between the strobe light and the camera. While this did improve picture quality, it did not affect the 30-foot or so limit on the camera-strobe's range. In addition, we increased the picture-taking frequency in the new unit to one frame every 15 seconds to give better time resolution. To give our camera-strobe system a longer active life in the loch, we also included a new triggering system in which the system was attached to the sonar through a computer constructed by United States Scientific Instruments. Only when an object with a cross-section of four to five feet entered the beam, at a distance of less than 40 feet, would the camera begin taking pictures.

As a backup system in the 1975 expedition, the 1972 apparatus was used, again separating the camera and light to minimize backscatter. The apparatus was mounted on a tubular frame, with a camera-light separation of about five feet. When suspended from the boat, the light would be on top flashing straight out into the water, and the camera hanging below aimed slightly upward. The backup system was set to take pictures at

The Environment in Loch Ness

This ecological analysis of Loch Ness is excerpted from the more extensive analysis of the phenomenon in The Monsters of Loch Ness *by Roy P. Mackal, The Swallow Press, Inc., Chicago, Illinois, 1976. Professor Mackal has been a Professor of Biochemistry at the University of Chicago for 20 years and is a director of the Loch Ness Investigation Bureau, which studied the Loch Ness phenomenon until 1972.*

In hypothesizing the existence of large creatures inhabiting Loch Ness, we must consider whether the physical and biological characteristics of the loch would even allow such a hypothesis. This analysis considers the various features of the loch, in relation to the categories into which a Loch Ness monster might fall — mammal, reptile, amphibian, fish, invertebrate. As you will see, the information thus far about the loch indicates it is quite capable of supporting a small, viable population of large predators.

The temperature of the loch is a relatively constant 42°F below the thermocline (the boundary between the variable upper layer and cold lower layer). The loch never freezes at its surface. The latitude of Loch Ness is 56°N, which normally would be almost subarctic if located more centrally in a large continental land mass, but the tremendous heat capacity of the North Atlantic and the warm Gulf Stream combine to reduce the extremes of heat and cold at that latitude of Scotland, producing warm winters and cool summers.

Living forms of the mammalian order sirenia — manatees, and dugongs, or sea cows — are restricted to tropical waters, but the extinct Steller's sea cow was a four-ton animal found in arctic waters, so there is no reason that such an aquatic mammal would not be at home in the waters of Loch Ness.

The low temperature of the loch seems to rule out a reptile hypothesis. However, studies at Woods Hole Oceanographic Institute on the large leatherback turtle have found that they readily maintain body temperatures and remain active in waters of 45°F. Dr. Wayne Friar and his colleagues placed two such animals in waters of this temperature for 24 hours and recorded a deep body temperature afterward of about 78°F. The underlying mechanism for such heat maintenance is probably heat production through muscular activity and heat retention aided by a large body mass. Further, the information regarding the size of the Loch Ness monsters indicates they are much larger than the leatherback turtle. This means a larger mass-to-surface-area ratio, making heat retention even more efficient.

In contrast to reptiles, amphibia have adapted to a very wide range of temperatures, from tropical regions to the permafrost regions of Siberia. Stability of the temperature is a prime requisite, which would make the constant year-through temperature in Loch Ness a most suitable environment for large aquatic amphibians.

Some have advanced the possibility that the Loch Ness monster is a large eel, and there is no question of the suitability of the temperature of the loch for eels, since small eels are thriving in the lake. Also, it has been suggested that the animal may be a mollusk (snails, squid, etc.), and the temperatures in Loch Ness present no problems for these creatures.

None of the candidate species is ruled out because of the freshwater conditions of the loch. Those animals, such as sirenia and reptiles, which are saltwater species could easily have swum up the rivers into the loch to escape predators or pursue prey, and could have adapted to the loch. Although the plesiosaur, one likely reptile candidate, was mainly, if not exclusively, a saltwater animal, fossil records have been discovered in areas indicating freshwater conditions.

Zoologists concerned with the Loch Ness creatures often ask: "But what would they eat?" Obviously no single animal could survive over the hundreds of years during which sightings have been reported, so the animals must be present in sufficient numbers to assure reproduction and to withstand attrition from disease and other natural causes. Such a group of large aquatic animals must consume a substantial amount of food. How much food is required for a particular kind of animal depends not only on its size, but also on its metabolic rate and energy requirements for maintaining its activities. An aquatic mammal, for instance, consumes food equal to 1 to 10 per cent of its own body weight per day. This requirement is the highest of any of the candidate categories, since mammals would be required to maintain a body temperature above that of the cold loch water. Daily food requirements for a variety of aquatic predators are 0.001 per cent to 1 per cent of body weight.

The requirement that Loch Ness monsters be predators stems from the low levels of plant life in the loch. The peat-stained water of the loch severely limits light penetration; consequently plant life grows only in a few shallow areas, being insufficient to support even a small group of large herbivores. Loch Ness is also lean in its content of freshwater plankton.

Many life forms in lakes such as Loch Ness ultimately depend on the sea for subsistence. The loch is connected to the sea via the River Ness, Loch Linnhe, and the two sections of the Caledonian Canal.

Although vegetation is lacking, fish could provide an adequate food supply for our Loch Ness monsters. The loch contains an abundance of sea trout, pike, stickleback, char, eels and salmon. And among these, salmon could be a key source of food for our colony of creatures.

We made a rough calculation of the number of these migrating salmon, working from a 1971 underwater photograph of the shoals of salmon migrating into the River Enrick, at the mouth of Urquhart Bay, to swim upstream and spawn.

From this photograph, we computed that the population density of fish in this entry zone into the river during migration was 0.2 fish per square foot. This would mean a population of about 300 fish in the 1400-square-foot entry zone to the river, which we reduce to 150 to account for the reduced densities in the outer fringes of the area.

From fish migration speeds and sizes, we calculated that about 36,000 fish per hour entered the river at the peak of the four-day migration, making an average migration rate, we believe, of 18,000 fish per hour. This means a total of about 1,700,000 fish may have entered the river to spawn during this period. This is not such an unusual figure; in Alaska's Kvichak River a migration of nine million sockeye salmon has been recorded in nine days. Also, it might seem that the entrance into the Enrick of that many salmon might hopelessly clog the river. However, we calculate that a given fish will spend only 12 hours in the river because of the prox-

imity of the spawning grounds to the mouth, and that population densities in the river during spawning remain well below that which the fish easily tolerate at the river's mouth.

Since there are six major rivers like the Enrick entering the Loch Ness, plus some 30 smaller streams, we estimate that prior to their spawning, the Loch Ness could contain up to 13 million adult salmon. Using an average weight of ten pounds, this would mean a total weight of 65,000 tons. The periodic nature of this food supply would present no difficulty, because many aquatic carnivores feed heartily during annual cycles when food is plentiful and fast during lean periods. However, fish predators in Loch Ness do not have to wait a year: in addition to the inward migration of adult salmon for the spawning season, there is the outward migration of the two-year-old juveniles making their way to the sea. Thus, the migratory cycle produces within Loch Ness another and even greater food source, one not periodic but constant in its supply. Feeding in Loch Ness and its tributaries at any given time there may be up to 19 billion juvenile salmon with a total weight of 680,000 tons, according to our calculations.

How many predators might migratory salmon support? Considering only the juvenile salmon, if 10 per cent were lost per year to predation, this would mean a food supply of 68,000 tons. If the average predator consumed 1 per cent of its weight per day (365 per cent per year), this would mean the total body weight of predators in the loch would be 68,000 tons ÷ 3.65 = 18,600 tons. Assuming that the large unknown predators in the loch represent only 1 per cent of this predator weight, we arrive at a total weight of 186 tons (372,000 pounds). Sonar evidence and sightings suggest a length of 20 feet for the creatures, meaning a weight of 2,500 pounds. Thus 150 to 200 large creatures could be supported on the migratory juvenile salmon alone. If the creatures were smaller or their intake requirements more modest, this would raise the upper population limits even further. Of course all these figures are quite rough, and are meant only to make the point that there appear to be large stocks of migratory salmon, capable of supporting a viable population of large predators. Even if the upper limit of our salmon population estimate were reduced by tenfold, the juvenile salmon could still provide food for 15 to 20 large fish predators.

Could Loch Ness support a small population of large animals even if no migratory food were available? This question has been explored by A. W. Sheldon and S. P. Kerr of the Bedford Institute of Oceanography and by W. Scheider and P. Wallis, in two papers published in the journal *Limnology and Oceanography*. Both groups calculated a possible population density of monsters in Loch Ness based on estimated stocks of living organisms in the loch. Sheldon and Kerr calculated the range of the total mass of monsters as between 7,000 and 34,500 pounds. Assuming 220 pounds per monster, the number of monsters in the loch could be as many as 156. Scheider and Wallis used an alternate method of calculating, but arrived at similar biomass estimates — 34,600 pounds. They suggest that the total populations of our animals in Loch Ness might range, depending on weight, between ten large monsters and 157 small monsters.

Of the many candidates for the Loch Ness monster, the requirements that it be fish-eating rules out only the herbivorous sirenia. Plesiosaurs were superbly adapted for catching fish, and in some fossil remains, fish and other animals were found in the stomach cavity. Among amphibians, eels, and mollusks we also find very effective fish predators.

1.2-minute intervals, giving a potential recording time of 40 hours before reloading was necessary. Page 39 shows a diagram of the arrangement, with the sonar-controlled camera station installed on a bottom ledge, mounted on a concrete base, at a depth of 80 feet. The auxiliary system was suspended from a boat (at the expense of strained backs by Rines and Dinsdale) above the primary system, 40 feet beneath the surface and 40 feet above the bottom ledge. These distances are important because they indicate that at no time could the backup system have photographed the bottom in the murky water.

The cone of the strobe light can be used to gauge distances from the camera. The light cone and camera field intersect at about ten feet, so any object within the field of view and ten feet from the camera will be brightly illuminated, while anything 20 feet away will have its upper part in shadow. Also, objects close to the camera would be illuminated only by scattered light outside the main beam of the strobe light (*see p. 39*).

The sonar record did show large objects near the camera but we later discovered that the main camera had been blocked by silt stirred up from the mud bottom. We know the silt was stirred up by the animal, because divers confirmed that the camera was clean after it was put on the bottom. Fortunately, however, the auxiliary camera functioned properly and in one 24-hour period provided the pictures on the next pages. The preceding and following frames show that the object photographed is "new" and was not present in the camera's range in the period preceding and following. The frames also show that the camera was subjected to agitation before and/or after several of the photographs. Normally all that would appear on the film would be blackness as the strobe light flashed out into the murky loch waters.

Photograph **A**, taken at 9:45 p.m. on June 19, shows what appears to be a portion of a larger, pinkish object, in the lower left corner of the frame. Remember that these and subsequent photographs could not have been pictures of the bottom — it was too far away — and calibration photographs we have taken show that the smooth loch bottom shows little resemblance to the objects photographed, as you can see on page 30.

Photograph **B**, taken at 10:30 p.m., shows what appears to be a portion of a large cylindrical object, about ten feet from the camera. The distance was known, because light densitometer measurements showed that the reflected light, which made an exposure on the film, was that expected for a ten-foot distance. The cylindrical nature of the object is indicated because the light falls off regularly at the far and near edges, while light does not fall off from one end to the other. The distance from the near line of shadow, or terminator, to the far edge, or limb, indicates a diameter of about six feet.

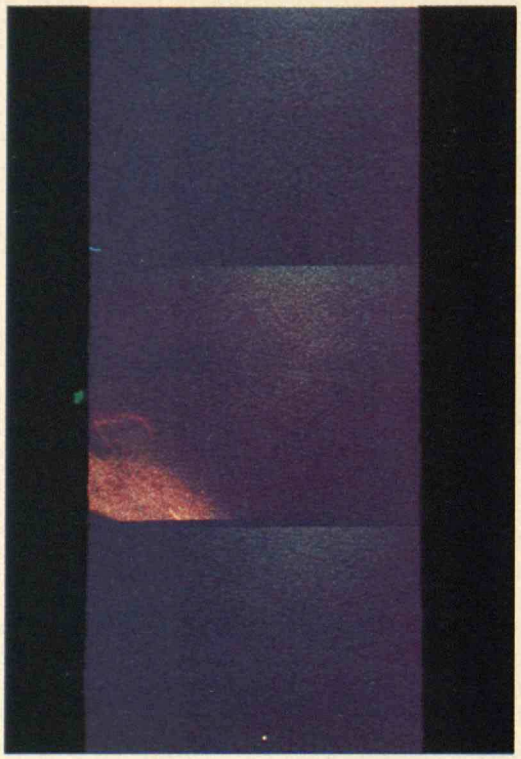
Photograph **C**, taken about 4:32 a.m. on June 20, shows what appears to be upper torso, neck, and head of the "creature." The body surface is dappled.

According to the densitometer measurements and the light-cone measurements mentioned earlier, the picture shows that the body was about 25 feet from the camera and extends from the bottom of the frame about one-quarter way into the frame. The neck would not be fully illuminated in such a position, but one could assume that the lit upper portion of the frame is connected to the lower portion.

As we interpret it, the neck portion of the object ex-

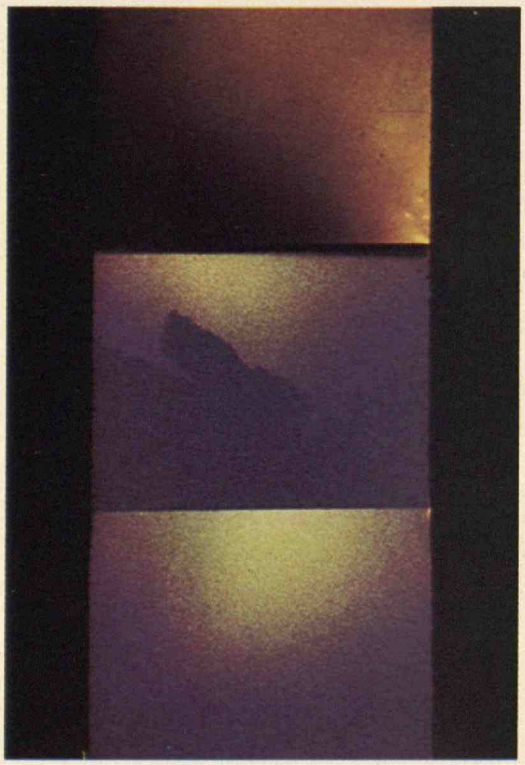
Continued on page 38

A At 9:45 p.m., June 19, 1975, the first unknown object was photographed by the backup system. Note that the object was not present in the preceding and following frames. (Academy of Applied Science)

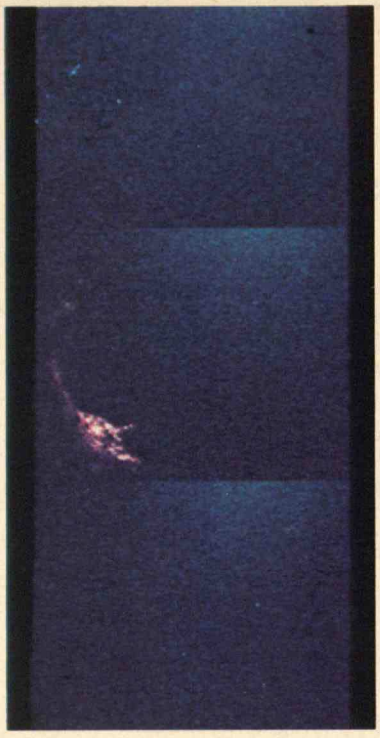


B At 10:30 p.m., June 19, a large cylindrical object was photographed for a single frame only, and at a distance of ten feet from the camera. It is thought to be cylindrical because light falls off at the far and near edges, but not at the right or left edges. Measurements indicate a diameter of about six feet. (Academy of Applied Science)

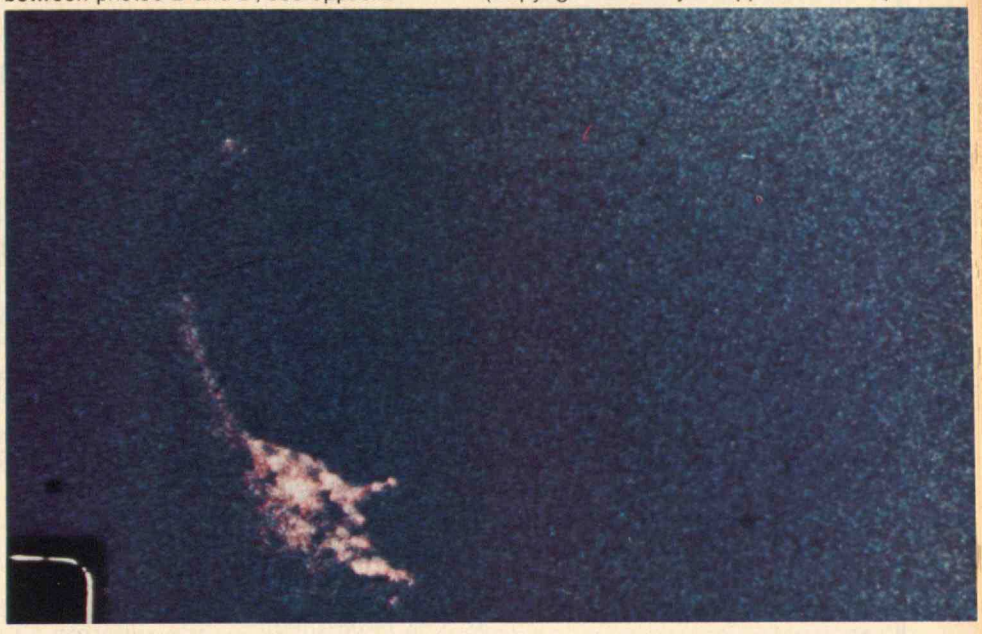
D Around 5:40 a.m., June 20, a photograph of another unidentified object was obtained. It was immediately preceded by evidence of the camera being perturbed and tilted upward toward the boat some 70°. (Academy of Applied Science)

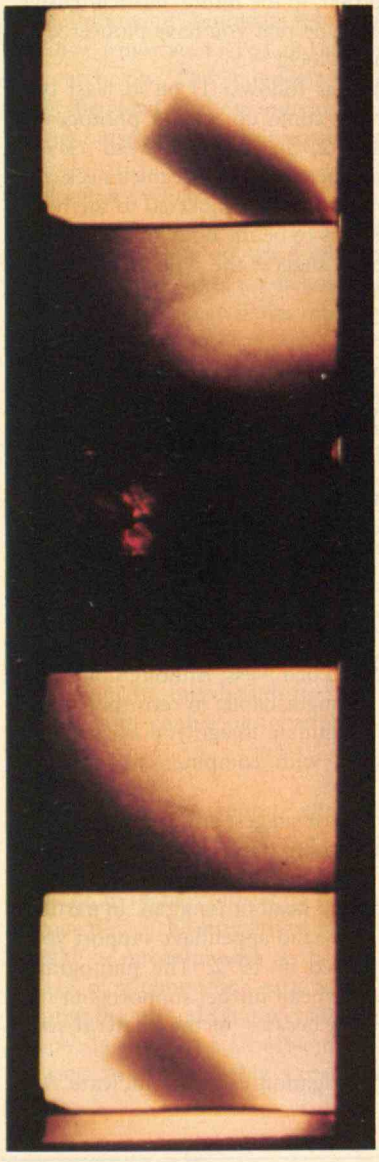


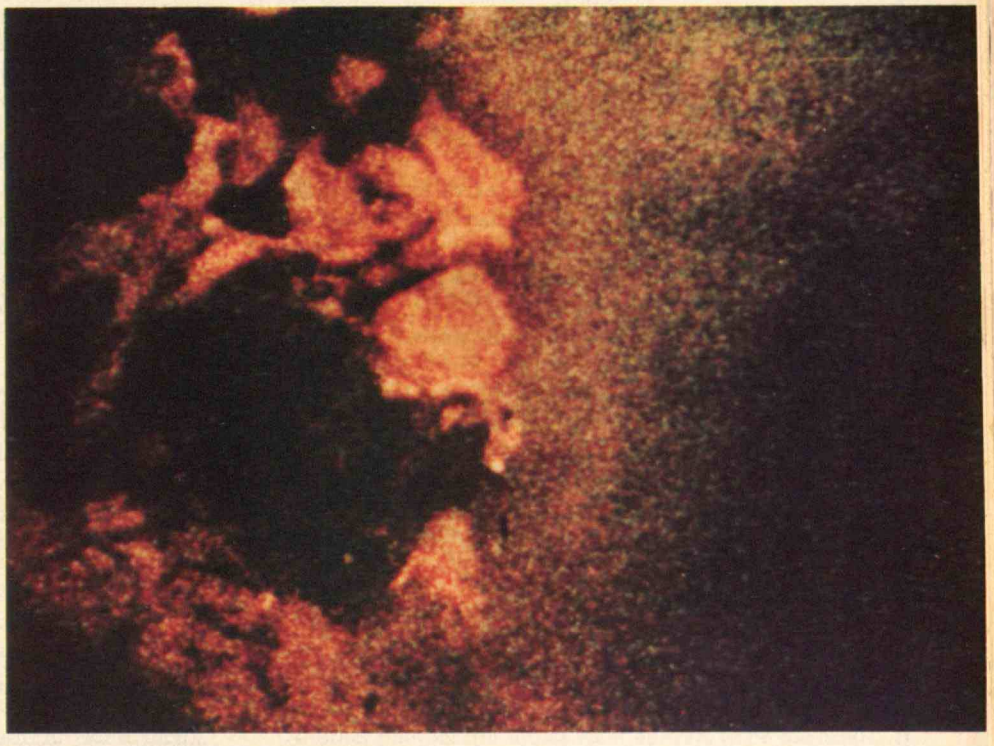
F A further photograph, obtained about 4:50 p.m., June 20, shows a silhouetted image slanting diagonally, in one frame only. It was obtained shortly after the camera was agitated. (Academy of Applied Science)



C At 4:32 a.m., June 20, a photograph was obtained on a single frame only of what appears to be the upper torso, neck and head of a living creature. (Photo taken between photos **B** and **D**; see opposite page.) Light cone and densitometer measurements indicate the body was at a distance of 25 feet, and, thus, that the object must have been about 20 feet long. (Copyright Academy of Applied Science)







E This series of seven frames (film strip at left; top and bottom not shown in full) was taken around 11:45 a.m., June 20 (between photos **D** and **F**; see opposite.) It records a period of major disturbance, with the camera swinging upward, in the middle of which the "head" photograph was obtained. The bilateral symmetry of the object strongly suggests that it is the head of a living creature. The object was about five feet from the camera, and about two feet long, although precision is impossible, because the entire object is not in the frame. (Copyright Academy of Applied Science) At the left: A painting by British naturalist Sir Peter Scott shows one interpretation of the "head" shot.

Scientists on the Loch Ness Photographs

The following are excerpts from statements by various experts, after having examined the 1972 and 1975 evidence on the Loch Ness phenomenon. Unless otherwise indicated they were all presented at a symposium on the subject in the British Parliament on December 10, 1975.

"The following statements represent my personal opinion. These statements do not represent an official view of the Smithsonian. The data gathered in 1972 consist of a 16-mm. film and a continuous sonar record. One part of the sonar record clearly shows a series of small objects and several larger objects. Sonar experts interpret the smaller objects as fish and the larger objects as animate objects in the 20- to 30-foot size range. I concur with this interpretation and further suggest that these are fish and the recently described *Nessiteras rhombopteryx,* previously known as the Loch Ness monsters.

"Computer enhancement of the 16-mm. film frames taken at the same time as the sonar record of large animate objects reveal a number of objects. The most distinct image is of a rhomboidal shape attached by a narrow base to a larger object. I interpret this as a flipper-like appendage protruding from the side of a robust body.

"The 1975 16-mm. film includes several frames containing images of objects which possess symmetrical profiles, which indicate that they are animate objects or parts thereof. I would suggest that one of the images is a portion of the body and neck, and another a head.

"I believe these data indicate the presence of large animals in Loch Ness but are insufficient to identify them. This new evidence on the existence of a population of large animals in Loch Ness should serve to encourage research on the natural history of Loch Ness and its plant and animal inhabitants, and remove the stigma of 'crackpot' from any scientist or group of scientists who wish to investigate the biological and limnological phemomena in Loch Ness."

George R. Zug, Ph.D.
Curator, Division of Reptiles and Amphibians
Smithsonian Institution
Washington, D.C.

"The following represents a personal opinion and does not represent an 'official' view of the Royal Ontario Museum. Having assessed the photographic and sonar evidence collected in 1972 and 1975 by investigators from the Boston Academy of Applied Science, and, having considered other data pertinent to the Loch Ness phenomenon, I have arrived at the following:
1) I have no reason to doubt the integrity of the investigators of the Boston Academy of Applied Science, or the authenticity of their data.
2) I am satisfied that there is a sufficient weight of evidence to support that there is an unexplained phenomenon of considerable interest in Loch Ness; the evidence suggests the presence of large aquatic animals.
3) The Loch Ness phenomenon should be the subject of a consolidated interdisciplinary research effort.
4) Steps should be taken to protect against irresponsible activities in and around Loch Ness."

Christopher McGowan, Ph.D.
Associate Curator
Department of Vertebrate Paleontology
Royal Ontario Museum
Toronto, Canada

"I personally find them [the photographs] extremely intriguing and sufficiently suggestive of a large aquatic animal to both urge and recommend that, in the future, more intensive investigations similar to the type that you have pioneered in the past be undertaken in the loch.

"My reasons for this are as follows: 1) on at least two separate occasions you have come up with a photograph suggestive of an appendage; 2) the so-called 'head' clearly seems to be a relatively small head on a rather thick neck and may match up with the object faintly connected to the body in the photograph which seems to be the body of a large animal . . . I am unable to even suggest the type of animal to which the head belongs."

A. W. Crompton
Professor of Biology
Director of the Museum of
Comparative Zoology
Harvard University
Cambridge, Massachusetts
(presented by Robert Needleman, Academy of Applied Science)

"The 1975 photographs certainly support the belief that a large aquatic animal inhabits Loch Ness. Although the identity of the creature is not distinguishable, in retrospect these photographs reconfirm the animate image you obtained in 1972, which was reinforced with computer-enhancement techniques.

"We are unable to interpret or suggest any assignment of a name to this creature . . . the photographs lead one to believe that the object is animate with proportionally large appendages and either a long neck and head or long tail. In particular the photograph of the body and appendage support your previous photographs obtained in 1972. The photograph which has been designated the head further supports our impression of an animate object because of the bilateral symmetry.

"The results of your investigation certainly indicate that

additional evidence is needed and more action should be taken in the immediate future to solve this mystery. We hope that you will be able to continue your efforts to identify the creature. On the other hand, we must take whatever action feasible to protect the animal and its environment from man's direct actions once your evidence is made public and make sure that man's indirect actions on the environment through pollution, increased boat traffic, etc., does not prevent us from learning more about the creature or even more regrettably leads to its extinction."

David B. Stone, Chairman
Henry Lyman, Vice Chairman
John H. Prescott, Executive Director
New England Aquarium
Boston, Mass.

"The following comments represent the unanimous view of the five senior zoologists and palaeontologists whose names appear below. The statement should be taken to represent only the views of these individuals and not an 'official' view of the museum — in fact no such corporate view can exist.

Preliminary remarks

"— We have no grounds for doubting the authenticity of the photographs, nor do we doubt the integrity of the investigators, but we have no means of eliminating the possibility that a hoax has been perpetrated by a party unknown to the photographic team.

"— We believe that none of the (1975) photographs is sufficiently informative to *prove* the existence, far less the identity, of a large living animal. Therefore any comment on the photographs can only be speculative. The most that can be done would be to assess the probability of any interpretation being correct.

"With regard to the photographs taken in 1972 (one of which has been published in *The Photographic Journal*), Dr. Zug, of the United States National Museum of Natural History, has said that "computer enhancement of one frame produces a flipper-like object." We cannot disagree with this comment, but the information in this photograph is insufficient to enable us to attempt even the broadest identification.

Comments on the separate photographs (1975)

"Photographs 1 and 2 marked 'head' and 'neck': This probably should be interpreted as two objects since there is no trace of an image connecting the 'head' and 'neck.' If it were all one object the strength of the images of 'head' and 'neck' would be incompatible with the complete absence of an image of a connecting structure. We have no obvious interpretation. If indeed it were a single object, it would have a shape suggestive of an elasmosaur, but the outline is very blurred and conceivably various floating objects could assume this form. We are intrigued by the reflectivity of this object. It occurred to some of us that this might be attributable to the presence of a large number of small gas bubbles such as are found in the air sacs of the larvae of phantom midges (*Chaoborus* sp.) which are known to occur in large swarms. The movements of phantom midge larvae involve a pelagic nocturnal phase and a benthic diurnal phase. These insects are known to occur in Scottish lochs but we have no data on their abundance nor on the size of their swarms."

(With the exception of the "head" photograph the Museum scientists could not find the suggestion of an animal in the other 1975 pictures).

J. G. Sheals, Keeper of Zoology
G. B. Corbet, Deputy Keeper of Zoology
P. H. Greenwood, Fish Section,
Department of Zoology
H. W. Ball, Keeper of Palaeontology
A. J. Charig, Curator of Fossil Reptiles
Natural History Museum, London
(Statement issued November 20, 1975)

"As a naturalist I have been interested in the possibility of large animals in Loch Ness since 1958 and was a founder board member of the Loch Ness Investigation Bureau. I have watched at the lochside, dived in the Loch and flown over it in a glider. So far I have not been lucky enough to see one of the animals.

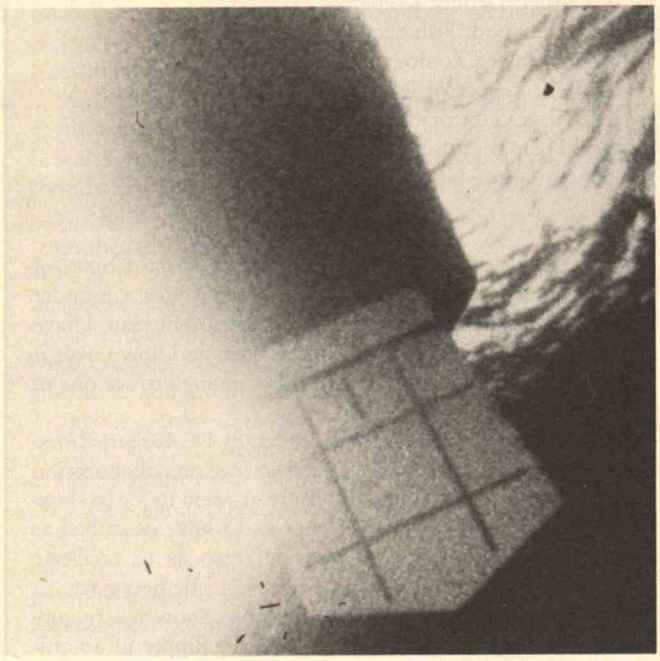
"The underwater photographs taken by Dr. Robert Rines' Team from the Academy of Applied Science, in collaboration with the Loch Ness Investigation Bureau, seem to me to show parts of an animal which Dr. Rines and I have described as *Nessiteras rhombopteryx*, in particular so as to facilitate conservation measures which we believe to be necessary.

"In particular two of the photographs show a structure which to my eye cannot be other than the flipper of an animal. The fact that there are two photographs taken about one minute apart which show a slight variation in shape is entirely consistent with consecutive aspects of an animal paddle which has moved slightly between pictures. To me the second picture makes the first enormously more significant.

"Another photograph shows what appears to be the head, neck and front of the body of one of the creatures which recalls the shape of certain fossil specimens from prehistory.

"In conjunction with a number of earlier records, on film and in still photographs, which cannot be explained in terms of known phenomena, the underwater pictures leave no further doubt in my mind that large animals exist in Loch Ness."

Peter Scott
Chairman, Survival Service Commission of
International Union for Conservation of Nature
Chairman, World Wildlife Fund.



A typical calibration shot of a known-size underwater object in Loch Ness. The object is about ten feet from the camera underwater. (Academy of Applied Science)

tends forward about ten feet, so the head would be only about 15 feet away from the camera, casting a shadow on the neck portion. Adding the length of the neck segment to the 8-foot body segment, one obtains a total length of about 18 feet, and the body probably extends for a considerable distance beyond the boundary frame of the picture. As in B, the torso is about 6 feet across.

Photograph D of an unidentified object at a distance of about eight feet was taken around 5:40 a.m., June 20.

Photograph E — a series of seven frames — was taken about 11:45 a.m. on June 20. The photographs preceding these show nothing in the camera's range. However, as the first frame of this series was taken, our apparatus apparently began to be rocked back and forth, quite unusual because we had never experienced any major currents in this part of the lake.

In the next frame the rocking motion had become so pronounced that the camera was swung up, aiming at the surface, and photographed the bottom of the boat (which is about 20 feet long, with a 7-foot beam). A measurement of the length of the boat in this frame indicates that the camera was about 35 feet below the boat, indicating that the apparatus had been lifted upward several feet. In the next frame, 1.2 minutes later, less of the boat shows.

Then, in the next frame we obtained the center shot; following this came more pictures of the water surface, and then blackness as before the episode.

The most likely interpretation of the center shot, it seems to us, is that it is of the head of a creature, with bilateral symmetry indicated, in half profile, with the nostrils and open mouth at the right, and several horn-like projections at the top. One interpretation of this photograph is shown in a painting by Sir Peter Scott beneath the frame. The object was about five feet from the camera, so it was illuminated only by scattered light outside the strobe beam and not the beam itself. Measurements indicate the "neck" to be about one-and-one-half feet thick, the "mouth" nine inches long and five inches wide, and the horn on the central ridge six inches long. There are two projections from the head, one before the "eye" on the near side, and the other, presumably, before the "eye" on the invisible far side. These projections are about ten inches apart. (Interestingly, this last measurement agrees well with the measurement of the distance between the tips of two projections producing parallel wakes photographed moving along the loch by Carol Rines, one day during the 1975 expedition. Photographs taken through a Questar telescope showed the wakes to move for a considerable distance along the loch, remaining parallel all the while — page 40.)

Because the entire "head" and details of its connection to the "neck" are not in the picture, it is impossible to make an accurate calculation of its size, but an estimation would be of about two feet long.

Photograph F was obtained about 4:50 p.m. and shows a rough-textured surface diagonally across the lower left portion of the frame. This picture was obtained shortly after the camera was violently disturbed again, as evidenced by photographs of the bottom of the boat, enlarged as if the camera had been moved upward.

It should be noted that throughout the film record were interspersed shots of eels, fish and other denizens of the loch.

Taken together, at the very least the 1972 and 1975 photographs, and the sonar evidence, agree well with one another and with past evidence that there is a species of large aquatic creature in Loch Ness. The 1975 body and neck resemble one of the objects in the 1972 series, as you can see on page 40.

Although we make no claim to being expert zoologists, we can find no combination of phenomena that account for these data as well as the simple explanation that a large creature inhabits the loch. Not even the experts have offered a plausible alternative explanation, in our view. In addition, there have been other investigations which suggest that the loch is capable of supporting a breeding population of such animals, and that physiological adaptation to the cold loch waters is quite feasible for a wide

variety of candidate species.

It is a philosophic rule that if a given set of data has more than one explanation, the true explanation is probably the simplest one. To put it another way, "the shortest distance between two points is a straight line."

We submit that it is a patent violation of this rule to explain away our data, as well as the reputable historical data on the Loch Ness phenomenon as a complex series of mistaken sightings, equipment failures, artifacts or hoaxes.

In any case many scientists have at least now agreed that these phenomena bear further investigation (*see scientists' statements on pages 36 and 37*); further expeditions will soon be underway, and we hope better data will follow shortly.

Because of the strong indications our evidence gives of the existence of this large aquatic creature, Sir Peter Scott has taken the lead in bestowing the scientific name *Nessiteras rhombopteryx* upon it, so that it may be eligible for protective legislation. *Nessiteras* is a composite word combining the name of the loch with the Greek word *teras,* genitive *teratos,* which means marvel or wonder. The specific name *rhombopteryx* is a combination of the Greek *rhombos,* a diamond or lozenge shape, and the Greek *pteryx* meaning a fin or wing. Thus, the name is

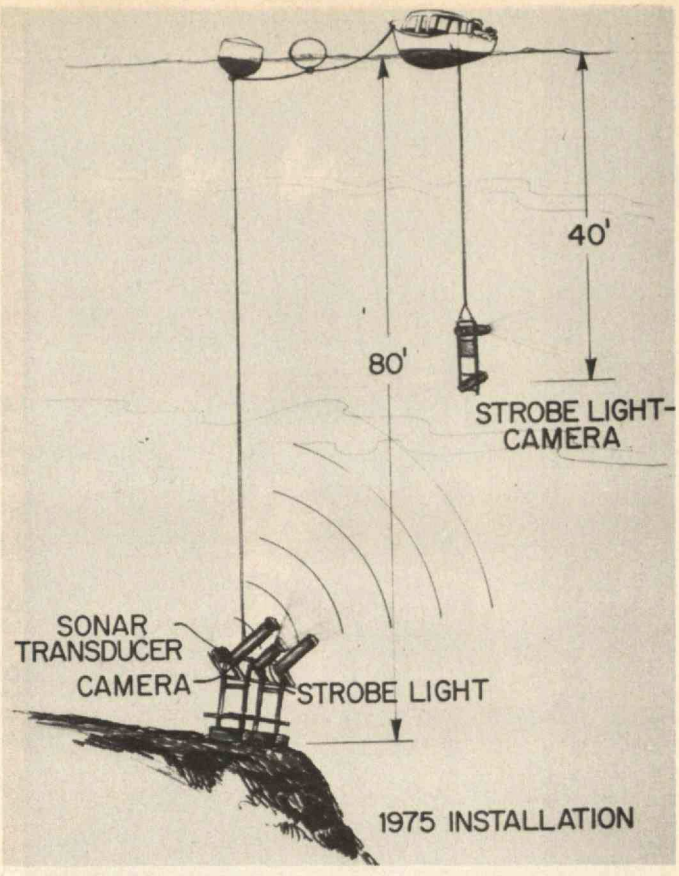
A Computer Expert on the Loch Ness Photos

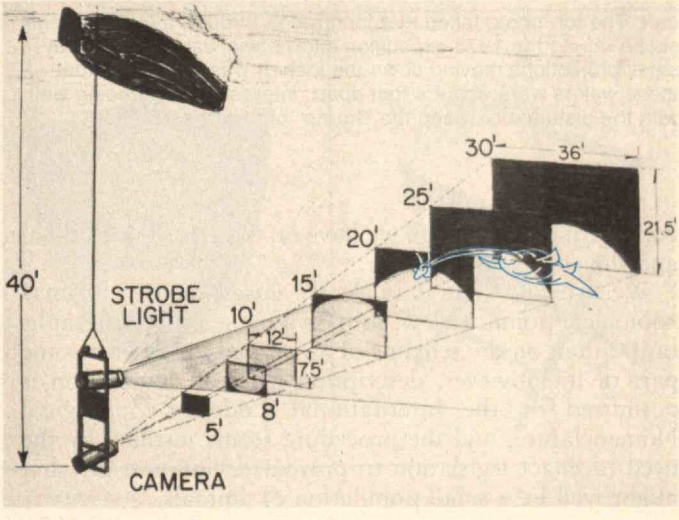
The following is from a report on the Loch Ness photographs by Alan Gillespie, a computer expert with the Jet Propulsion Laboratory, California Institute of Technology, who performed the computer enhancement on the photographs. It was presented at the symposium in Parliament by Isaac S. Blonder of the Academy of Applied Science.

"1972: Three frames taken while sonar showed large animals in or near the camera field of view themselves showed unusual shapes. These shapes were not artifacts, and did not appear in hundreds of frames taken when no sonar echoes were reported . . . Assuming ranges indicated by the sonar were correct, the size of the animal or animals seen in these pictures agreed with size estimated from the sonar record. One animal may have had a 16-foot body.

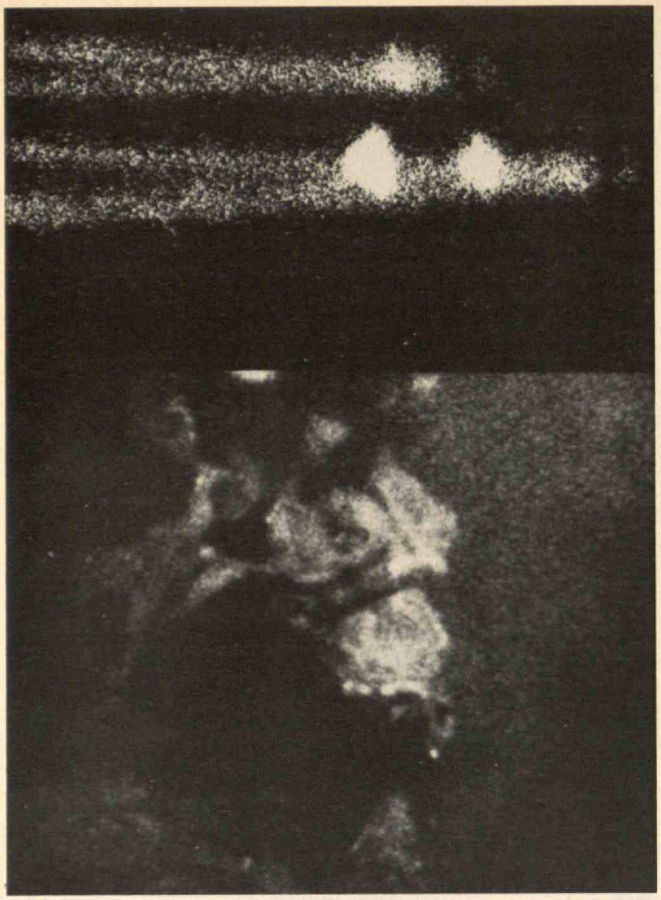
"One frame (the 'flipper') showed a fairly distinct, coloured object which I inferred was the animal or a portion of the animal. A final frame showed two objects, an interpretation which was consistent with the sonar record. One was much farther from the camera than the other, according to the sonar . . . the distant profile was about 12 feet long. The 'flippers' hanging down from it were about 4 feet long.

"1975: One picture showed a body with a long neck and two stubby appendages . . . the second frame appeared to show a neck and head, with the head closer to the camera than the body . . . the neck was reticulated. The head supported projections . . . I see no evidence that they are pictures of a model, toy . . . or whatever. I emphasize: I detect no evidence of a fraud. These objects are not patterns of algae, sediment or gas bubbles."

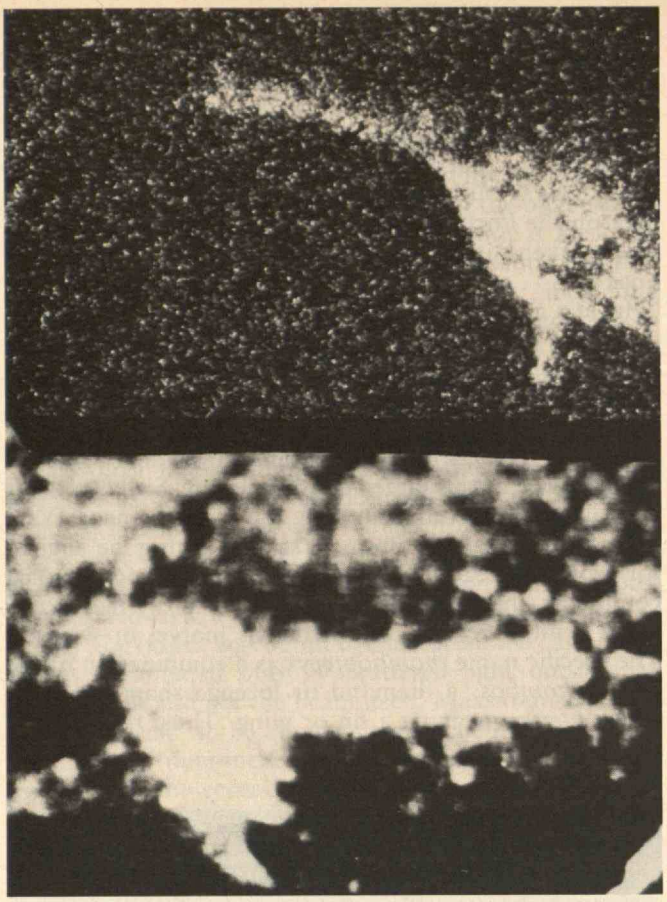




Top: The arrangement of equipment for the 1975 expedition. The sonar transducer, and sonar-activated camera were placed on a bottom ledge, and the backup system was suspended 40 feet from the bottom. The backup unit was the 1972 apparatus, with the camera and strobe separated by about five feet on a tubular frame. Bottom: Besides determining the distance of an object from the camera via light measurements, it was also possible in 1975 to use the geometry of the camera-strobe arrangement. Objects in the camera frame about ten feet away will be fully illuminated by the strobe beam, while objects framed at larger distances will have larger portions in shadow. The body-neck shot can be analyzed using this geometry, as shown. At a distance of 25 feet, the body of the creature would be fully illuminated on one side, and the head extending toward the camera and back into the light beam would also cast a shadow on the neck. (Academy of Applied Science)



Left: The top photo taken at a long range through a Questar telescope during the 1975 expedition shows twin wakes created by small projections moving down the loch. It was calculated that these wakes were about a foot apart, interestingly, agreeing well with the distance between the "horns" on the "head" shot



(Academy of Applied Science photograph by Carol Rines) Right: A comparison of the photographs of large moving bodies taken in 1972 (bottom) and 1975 shows a resemblance. (Academy of Applied Science)

consistent with the data we have on the size of the animal and the shape of its flipper.

We are told that it is clearly unsatisfactory, from a zoological point of view, to base a name on photographs rather than on the remains of an animal, or at least some part of it. However, description from an illustration is permitted by the International Code of Zoological Nomenclature, and the procedure seems justified by the need to enact legislation to prevent decimation of what might well be a small population of animals.

Suggested Readings

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Robert H. Rines is Dean and Professor of Law at the Franklin Pierce Law Center, Concord, N.H. He holds an S.B. in physics from M.I.T., a J.D. from Georgetown University, and a Ph.D. from National Chiao Tung University. He holds patents for inventions in the field of sonar and radar, and has lectured at M.I.T. on patent law for the past ten years. **Charles W. Wyckoff,** M.I.T. '41, is the owner of Applied Photo Sciences, Needham, Mass., and was formerly with EG&G, Inc. He has invented wide-exposure-range films used to record nuclear test explosions, and to photograph the surface of the moon in the Apollo program. His experience in underwater photography dates from World War II, when he developed photographic instrumentation for underwater Explosions. **Harold E. "Doc" Edgerton,** Institute Professor Emeritus at M.I.T., is the "father" of strobe photography, having invented the strobe light in 1931. his most recent inventions include cameras and electronic gear for underwater exploration. His devices have been used in underwater scientific research, to locate sunken ships, and by such explorers as Jacques Cousteau to film underwater life. **Martin Klein** is President of Klein Associates, Inc. and holds an S.B. in electrical engineering from M.I.T. He has designed numerous sonar devices for use in oil exploration, underwater mapping, and to search for sunken ships.

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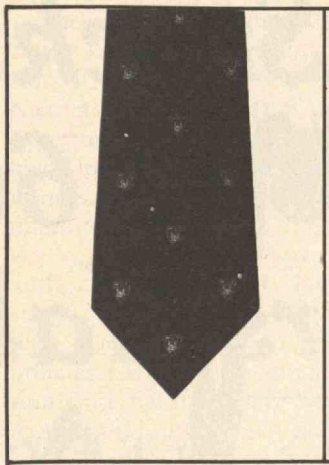

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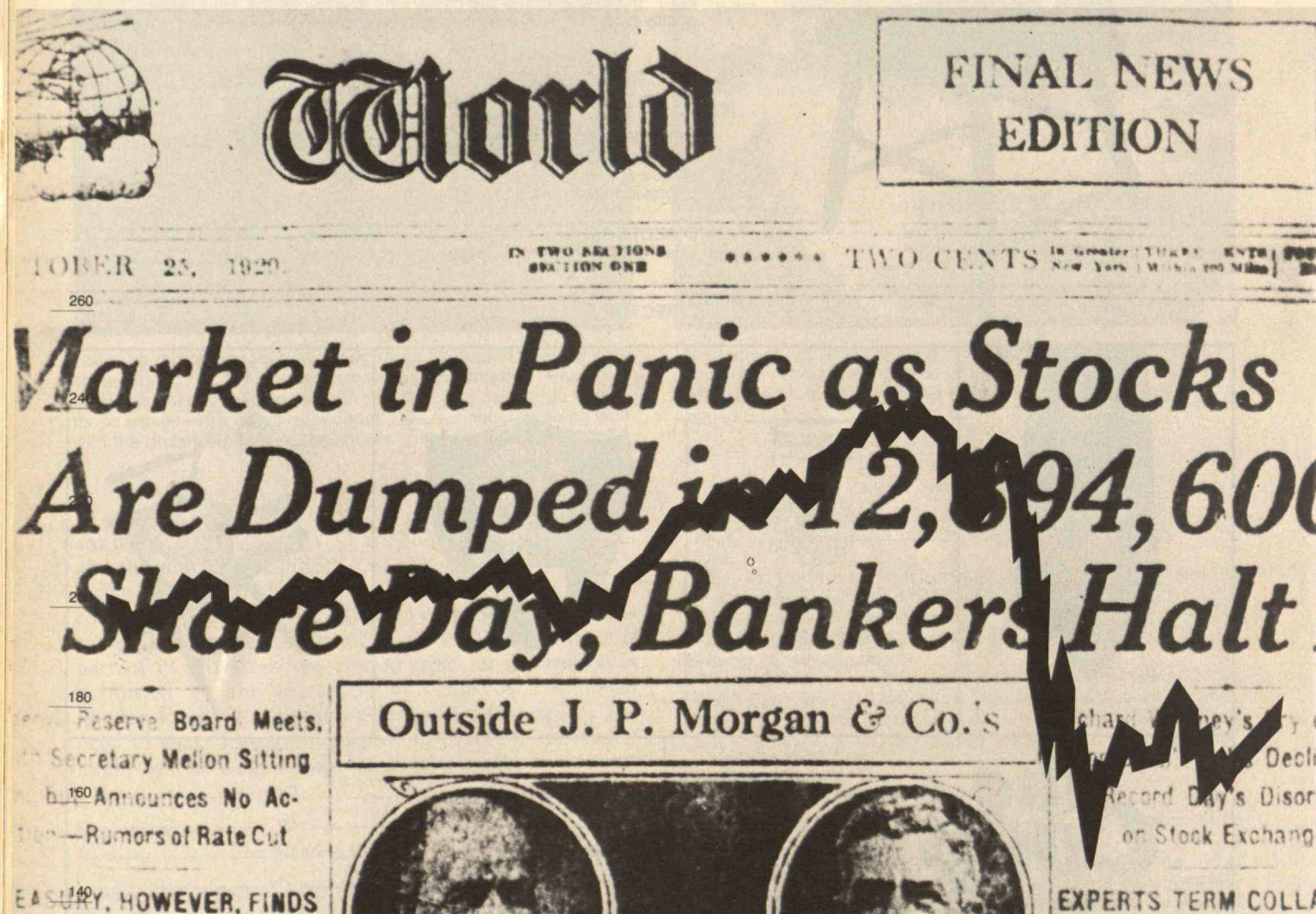
A dynamic, socio-economic model of the U.S. economy suggests that labor and production policies underlie the four-year business cycle while capital investment policies are associated with 20- and 50-year cycles of prosperity and depression



Though few have had the impact of the Great Depression which began with the collapse of the stock market in 1929 (above), business cycles have been a perennial feature of the U.S. economy. In this article, Professor Mass offers a new hypothesis for their source in cyclical amplifications of variations in production, inventories, and capital investment. (Photo: Bettmann Archive)

Nathaniel J. Mass
Assistant Professor of Management
M.I.T.

Modeling Cycles in the National Economy

High unemployment and faltering economic growth rates in the 1970s, together representing the deepest and longest recession since World War II, have sharpened our concern to understand and better control the cycles of prosperity and depression which are familiar in our national economy.

At least three cyclical fluctuations in the economy are recognized:
— The "business cycle" is a recurring oscillation of about four years in output, prices, investment, and employment.
— The "Kuznets Cycle" is an 18- to 20-year fluctuation in the rate of growth of capital.
— The "Kondratieff Cycle," at the long end of the spectrum, is a 50-year cycle in prices, interest rates, and capital investment.

There have been many studies of the properties and causes of the short-term cycles of prosperity and depression in modern societies, but very few of the long-term Kuznets and Kondratieff cycles. This article reports on experiments on the role of labor and fixed capital investment in generating short-term business cycles and long-term economic cycles, using a generic model of the production sector of the U.S. national economy developed in the System Dynamics Group under the direction of the author and Professor Jay W. Forrester. The results suggest that the four-year cycle, traditionally associated with investment policies, is in fact the result of business policies relating to the management of labor and production; and that the longer cycles are related more closely to fixed capital investment policies.

Capital and Labor as Sources of Cycles

Most theories of business cycles attribute fluctuations in income and output to fluctuations in fixed capital investment. These theories have been accepted widely, and they underlie most economic stabilization policies which focus on regulating investment opportunities and policies. However, a number of writers, including Moses Abramovitz of Stanford University, have taken exception to this analysis; compared with other factors of production such as labor or in-process goods, Professor Abramovitz says, fixed capital has a relatively long average lifetime and is characterized by long lead times in planning, financing, and completing new projects. These long time constants suggest to him that fixed capital variations cannot be a basic cause of short-term business cycles.

The proposition that fixed capital investment is not an essential element in generating the short-term business cycle has two principal dimensions: first, that business cycles can occur independently of changes in fixed capital investment; and second, that fixed capital variations cannot independently generate four-year cycles. Our computer studies show that short-term policies for production and inventory-management generate four-year cycles even if fixed capital stock does not vary; and, moreover, that four-year business cycles do not appear in an economy where capital is the only variable factor of production. These results demonstrate that fixed capital variations cannot be an intrinsic cause of four-year business cycles. On the other hand, our analysis of the basic production sector reveals that fixed capital investment may underlie the observed Kuznets and Kondratieff cycles.

If these results are correct, the theory and practice of economic stabilization must be expanded beyond the present predominant focus on the short-term business cycle; and national policy must be based on a deeper understanding of both short- and long-term trends in the economy and the probable effects of alternative policy actions.

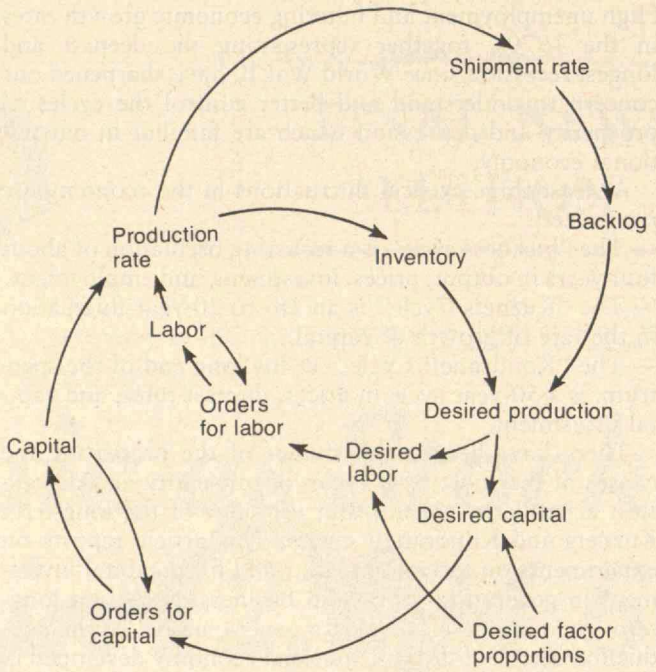
Modeling Cycles in the Production Sector

The computer model of the production sector used in these studies is a subset of a larger model of the national economy. The sector receives orders which accumulate in an unfilled order backlog. Based upon its production capacity and the levels of its inventories and order backlogs, the sector generates a shipment rate; the shipment rate depletes both inventory and order backlog. The production sector "decides" on a production rate based on the adequacy of its inventories and on the size of its order backlog. This desired production rate, in turn, governs the sector's needs for labor and capital. (For simplicity, only two inputs to production — labor and fixed capital — are considered in the analysis. Labor and capital are chosen as contrasting factors because labor is typically acquired readily and has a comparatively short lifetime within the firm while, as discussed previously, capital is a durable asset characterized by long planning and construction delays.) The sector's available inventories of labor and capital determine the production rate, and the discrepancy between actual and desired inventories of capital and labor controls the ordering of these inputs.

We have noted above that today's dominant theories link variations in capital investment to the short-term business cycle; and we have proposed that capital investment is unlikely to be an essential cause because of the relatively long delays associated with acquiring and depreciating capital plant and equipment. The relatively

short delays involved in labor recruitment and turnover suggest that labor adjustment could be an intrinsic cause of the short-term cycle — an important alternative to the capital-investment theory of business cycles.

To investigate these hypotheses, we ran a sequence of computer simulations. First, we considered labor as the only variable factor of production; the resulting simulation exhibited a four-year cycle in production, employment (labor), and inventory. A second simulation, which considered capital as the only variable factor of production, exhibited approximately a 15-year cycle in production rate and in the level of capital equipment. A third simulation considered both labor and capital as variable factors of production; it exhibited the four-year production, employment, and inventory cycle characteristic of short-term labor adjustments superimposed on a longer-term cycle in capital and potential output. Finally, a fourth computer simulation showed that a long wave in the economy, resembling the 50-year Kondratieff cycle, can arise from a scenario in which the capital equipment sector of the national economy must divert a portion of its output for its own use in producing capital equipment.



In the production-sector model used for this analysis of business cycles, desired levels of labor and fixed capital are governed by desired production, which is in turn governed by a feedback structure involving present production rate, shipment rate, backlog, and inventory. This model is a simplified version of one unit within the national socio-economic model now under construction and test by the System Dynamics Group at M.I.T.

Short-Term Cycles Induced by Labor Adjustments

To study how adjustments in employment induce economic cycles, we subjected the production sector in our model to a 15-per-cent increase in orders, with labor as the only variable factor of production. This simulation is intended to isolate the periodicities associated with labor hiring and firing. In the charts at the left, the increase in product consumption begins after one-half year during which production equals the incoming order rate of 3 million units per year and labor, inventory, and the backlog of orders are constant at their desired values.

The cycle of change begins when consumption jumps from 3 million to 3.45 million units/year and the backlog of unfilled orders therefore starts to rise; the increased backlog raises the shipment rate, thereby depleting inventory from 1.5 million units to approximately 1.45 million units at the end of the first year. Over the same time, the inventory desired according to management plans rises to 1.55 million units — a natural reaction to higher rate of consumption. At the end of one and one-half years, backlog has increased from 0.6 million to about 0.75 million units, while desired backlog rises over the same interval from 0.6 million to 0.65 million units. The resulting divergences of actual and desired inventory and backlog cause a rapid growth in desired production, from 3 million to 3.6 million units/year at the end of the second year. This rise in desired production causes a corresponding rise in desired labor from 1,500 to approximately 1,850 employees.

The production rate eventually rises to a maximum value of about 3.9 million units/year early in the second year in response to the increase in desired production. At this point the increase in production is 0.9 million units/year, double the increase in incoming orders. The peak in production slightly lags desired production due to delays in acquiring labor; but the lag is somewhat mitigated by the use of overtime to expand production, the relative length of work week rising to 1.07 (implying a seven-per-cent increase in the average work week) at the start of the second year. Production rate exhibits a four-year cycle between the second and sixth years, caused by inventory

Given the simplified production-sector model shown opposite, what is the effect of the sudden increase in consumption recorded at year 0.5 on the top chart? To analyze its effect, labor was in this example the only variable factor of production; that is, inputs of labor but not of capital could be increased in response to the new level of consumption. A complex series of adjustments and overcompensations ensues, yielding a cycle which seems to the author to have the basic characteristics of the widely-recognized four-year business cycle.

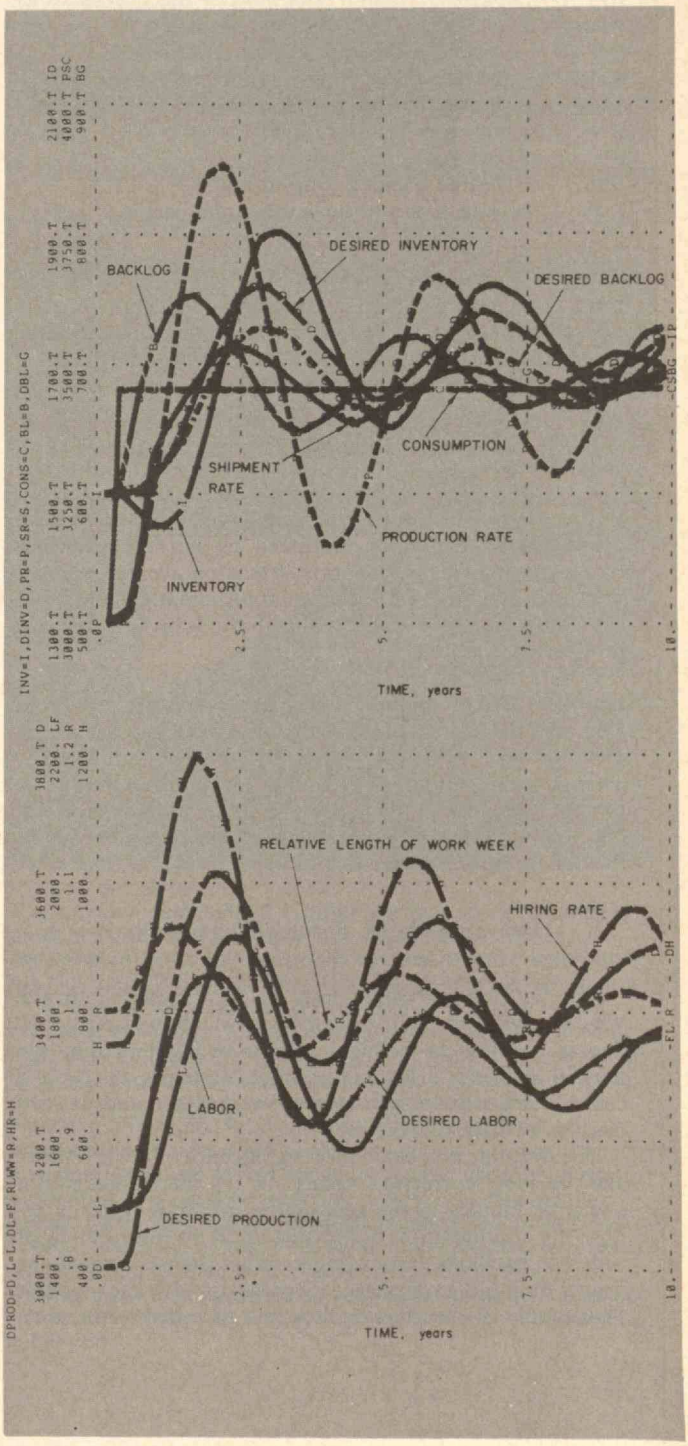
and backlog policies that induce successive overshoot and undershoot of production relative to consumption.

As long as the rate of production is below consumption and shipment rate, inventory continues to decline and the backlog of orders continues to accumulate. Consequently, inventory reaches a minimum value, and backlog approximately attains a maximum value at the point where production rises to just equal consumption. But even when production equals incoming orders, expansion must continue in order to eliminate the inventory shortage and large backlog. Thus desired production rises above consumption at the start of the second year and continues to remain above orders until approximately the third year. At the point where inventory equals desired inventory, at about two and one-half years, production rate exceeds incoming orders. Inventory therefore continues to rise above desired inventory. The resulting inventory surplus can be eliminated only if production falls below incoming orders for some period of time. In this way, inventory adjustments lead to production fluctuations around the incoming order rate. Backlogs similarly exert a destabilizing effect on production rate, thereby accentuating the effect of inventories. Output must rise above incoming orders to eliminate the large backlogs accumulated during the initial upsurge in demand. The fluctuations in production converge over time, a reasonable behavior since the consumption rate is assumed to be constant after the 15-per-cent increase.

All the relationships exhibited in the computer output (*see right*) appear to correspond closely with available statistical evidence on business cycles. For example, the backlog of orders leads production by approximately one-half year. Backlog peaks before production since the backlog of orders begins to decline as soon as the rate at which goods are shipped exceeds the rate of consumption; in contrast, production continues to expand beyond consumption, as discussed earlier, in order to build up inventory and reduce backlog to desired values.

The simulation also shows a slight lag — roughly one-quarter to one-half year — of labor behind production. Production declines even while labor is increasing because use of overtime declines as production begins to exceed desired production. Therefore, hiring rate peaks in our example (*at the right*) at year 1.5, but labor continues to expand because the hiring rate still slightly exceeds the termination rate (not plotted).

Finally, the simulation shows a one-year lag of inventory behind production. Since shipment rate tends to lag production slightly, inventory lags shipment rate by



Modeling the Production Sector

The drawing (*right*) provides a detailed view of the structure of the production sector. The production rate at the left is determined by the available stocks of labor and capital. Production rate adds directly to inventory and also affects shipment rate, with shipments rising with increased production capacity.

The production rate decision forms the nucleus of the production sector model. In the sector model,

DPROD = APROD + (DINV − INV + BL − DBL) / TCIB (1)

where

DPROD — Desired production (output units/year)
APROD — Average production (output units/year)
DINV — Desired inventory (output units)
INV — Inventory (output units)
BL — Backlog (output units)
DBL — Desired backlog (output units)
TCIB — Time to correct inventories and backlogs (years)

Equation (1) dictates expansion of output — an increase in production above the recent average production rate — whenever the sector's desired inventory exceeds available inventory or when backlogs are deemed excessively large. The coefficient TCIB controls the rate at which the sector attempts to eliminate inventory or backlog discrepancies.

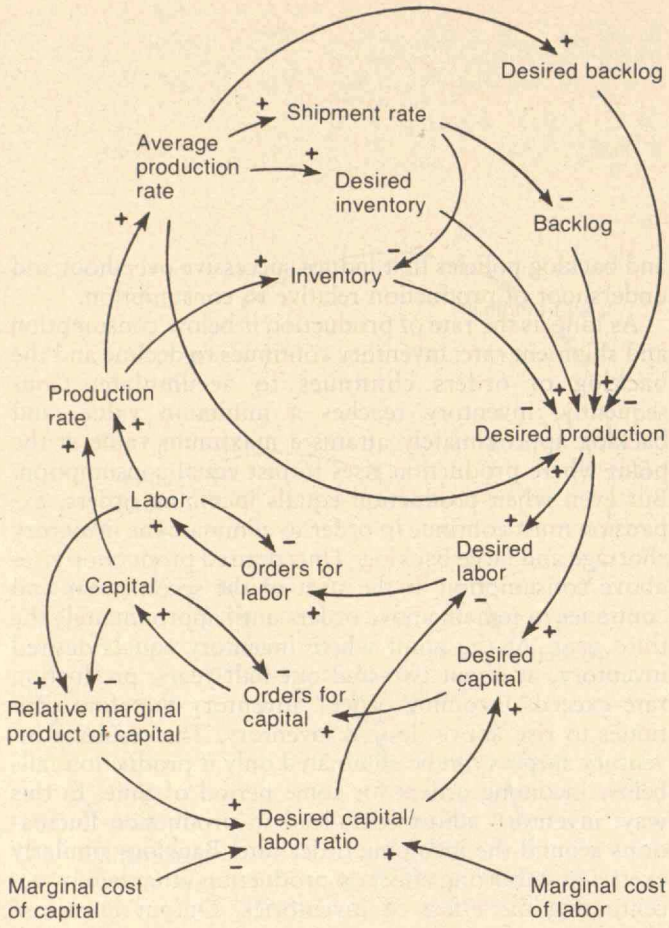
In the economics literature, desired inventories are typically assumed to depend on production or sales as a reflection of the level of activity of the firm. In the production sector, desired inventory DINV is assumed to equal average production rate APROD multiplied by normal inventory coverage NIC. This formulation, based on average production rate, may be regarded as an approximation to a more complex underlying structure that depends on both average production and sales.

Desired backlog DBL is assumed to equal average production rate APROD multiplied by normal backlog coverage NBC. DBL therefore represents the order backlog that would prevail if production and shipment rate were both equal to average production and delivery delay were equal in years to the value NBC. The correspondence between normal backlog coverage and normal delivery delay can be seen in the definition of delivery delay:

Delivery Delay = Backlog/Shipment Rate

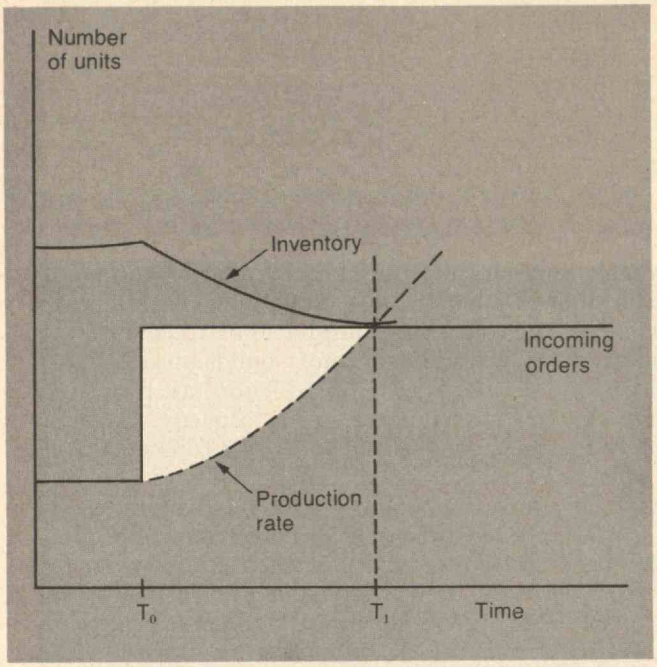
The backlog correction term in (1) therefore indicates whether, given the sector's current production capacity, orders in backlog can be filled in more or less time than the normal delivery delay. The sector attempts to expand capacity when backlogs are excessively large and to contract when backlogs are low.

The dynamic and behavioral significance of the inventory and backlog correction terms in (1) merit discussion. Dynamic models in the economics literature typically ignore the accumulation of production in inventories and of orders in backlogs. For example, rather than measuring the supply of goods by available inventory stocks, such models treat supply as a production flow rate governed by marginal



costs of production. Analogously, demand is considered as a flow of purchases (consumption), rather than as a level of unfilled orders. Finally, price changes are typically assumed to occur whenever supply and demand, measured as rates of production and consumption, are imbalanced. Such a representation of supply and demand, however, fails to capture the disequilibrium behavior, and, in particular, the amplification of production activity (the observed tendency of output to fluctuate by more than sales or incoming orders) characteristic of business cycles.

To understand this deficiency of traditional economic models, consider the response of inventories and production within a firm or industry to a step increase in incoming orders. As shown in the drawing in the next column, as orders increase, pressures arise to expand production. The increase in production rate is consistent with classical economic analysis. However, consider point t_1, where production has risen to equal incoming orders (consumption). According to the classical model, supply and demand are equal at this point, and there should be no further pressure on output or price. However, all during the period from t_0

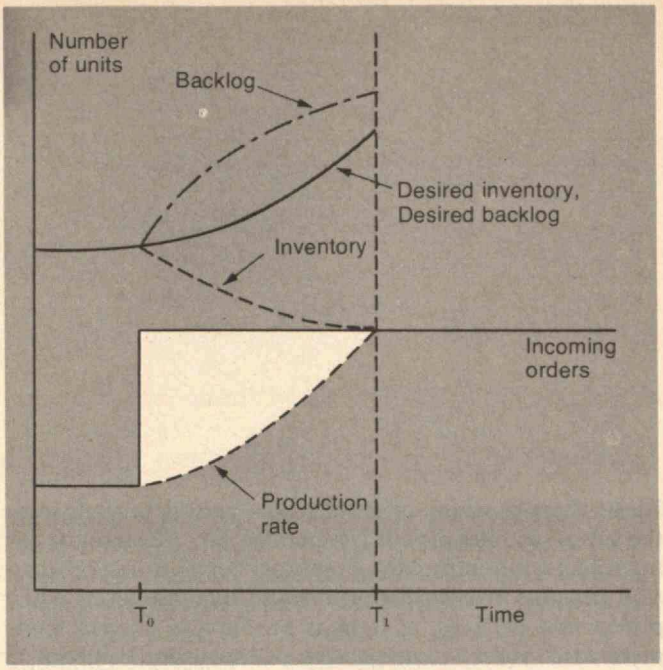


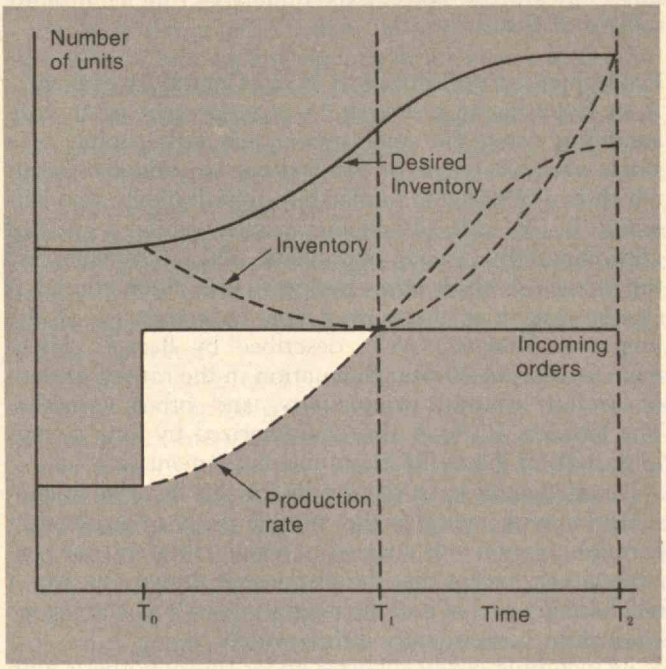
to t_1 (in which production remained below incoming orders), inventories have been depleted. The total inventory loss over this interval is equal to the integral

$$\int_{t_0}^{t_1} (\text{Orders} - \text{Production})\, dt,$$

which measures the accumulated excess of consumption over production. This integral is represented in the drawing above by the shaded area between the production and consumption curves. Therefore, at point t_1, supply equals demand in the rate-of-flow sense — production equals consumption — but inventory is below desired inventory which would probably rise over the interval t_0 to t_1, reflecting both increased production and sales. Such an inventory imbalance would necessitate additional expansion of output beyond the incoming order rate and would probably exert continued upward pressure on price. Therefore, the classical model of supply and demand which ignores inventory and backlog behavior fails to represent adequately the determinants of pricing behavior and, further, fails to capture the amplification and necessary overshoot of production engendered by changes in orders or consumption.

Desired production, together with the desired capital-labor ratio, determines the desired stocks of capital and labor. Comparison of the actual and desired stocks of capital and labor yields a discrepancy which modulates orders for the two factors. Finally, orders for factor inputs, after a delivery (acquisition) delay, add to the levels of capital and labor, respectively, thereby altering production capacity. — *N.J.M.*





These charts demonstrate in detail the characteristic behavior of production rate and inventory in response to an increase in consumption in the author's production-sector model when labor is the only variable of production. The cycle begins with an expansion of production resulting from an increase in incoming orders occurring at time t_0; production rises until it equals the incoming order rate at time t_1. However, at time t_1, inventory is below, and order backlog above, their desired values, and these discrepancies necessitate a continued expansion of production *above the incoming order rate*. Production continues to expand until inventory builds up to equal desired inventory; but once this occurs inventory continues to rise above its desired value because production now exceeds incoming orders. To eliminate the resulting inventory surplus, production must be reduced below the levels of incoming orders. Policies for managing backlogs result in similar destabilization, and together these changes and overcompensations produce a cyclical pattern which the author associates with the familiar four-year cycle of economic growth and recession.

about three-quarters of a year — a period very close to the seven- to nine-month lag cited by Dr. Abramovitz for manufacturing industries. Inventory tends to lag production because inventory continues to increase, even while production declines, as long as production exceeds shipment rate. Such a time-pattern of inventory behavior is observable in the aggregate economy as well as in many individual industries.

Economic Cycles Induced by Fixed Capital Investment

If we hypothesize a sudden 15-per-cent increase in consumption using the same model but with capital as a single variable factor of production, we obtain a result which is qualitatively similar but quantitatively very different. In this case all system variables exhibit a cycle of approximately 15-year periodicity. This is well beyond the range of short-term business-cycle fluctuations; it closely resembles the periodicities characteristic of the long-term Kuznets Cycle, described by Bert G. Hickman as a 15- to 20-year fluctuation in the rate of growth of capital, output, productivity, and other variables. The Kuznets Cycle is also characterized by long swings in growth of labor force and unemployment rate.

Detailed analysis of the results for this increase in consumption with capital as the variable factor of production parallels the previous analysis in which labor was the variable factor, except that the response is drawn out over a much longer period and the magnitude of lead and lag relationships consequently differs widely.

As incoming orders increase under this hypothesis with capital stock allowed to vary, inventory begins to decline and order backlog increases. Desired production rises as a result, thereby leading to increased orders for capital. However, in this capital-variable case there are relatively long delays due to the time required for planning and construction of capital plant, and these delay the acquisition of new capacity. By around the fifth year production has increased enough to equal consumption, thereby terminating the drop-off in inventory. But inventory has been steadily depleted in the meantime, while management's desired inventory has risen in response to increased production. By the fifth year, for example, an inventory of 1.25 million units compares with a desired inventory of nearly 1.7 million units, and a backlog equal to 0.9 million units compares with a desired backlog of 0.66 million.

To eliminate the discrepancies between actual and desired inventory and backlog caused by increased consumption, production must rise above consumption. Accordingly, capital rises from an initial value of 7.5 million units to about 10 million units at year 10 and continues to expand as long as desired production exceeds average production. However, as inventory builds up once more and backlog declines, desired production rate drops off, thereby gradually leading to excess capacity. Capacity remains in excess over several years as a consequence of the long delay in capital depreciation. There is a cyclical adjustment similar to that seen in the example where labor was considered the only variable factor of production. But, the response is protracted compared with the four-year cycles induced by labor adjustments. Addition of capacity is delayed on the production upturn due to increased acquisition delays; moreover, capacity is reduced on the downturn only slowly as a result of gradual "runoff" of capital through depreciation.

These results cast doubt upon theories that variation in fixed capital investment is an essential cause of the short-term business cycle. Instead, the results suggest that labor adjustments chiefly underlie short-term cycles in output and employment, while fixed capital investment generates longer-term cycles in growth of capital. But the results suggest that a common structure underlies both business cycles and longer-term capital cycles; differences in the characteristics of capital and labor — such as average lifetimes and delivery delays — suffice to explain the different periodicities of fluctuation.

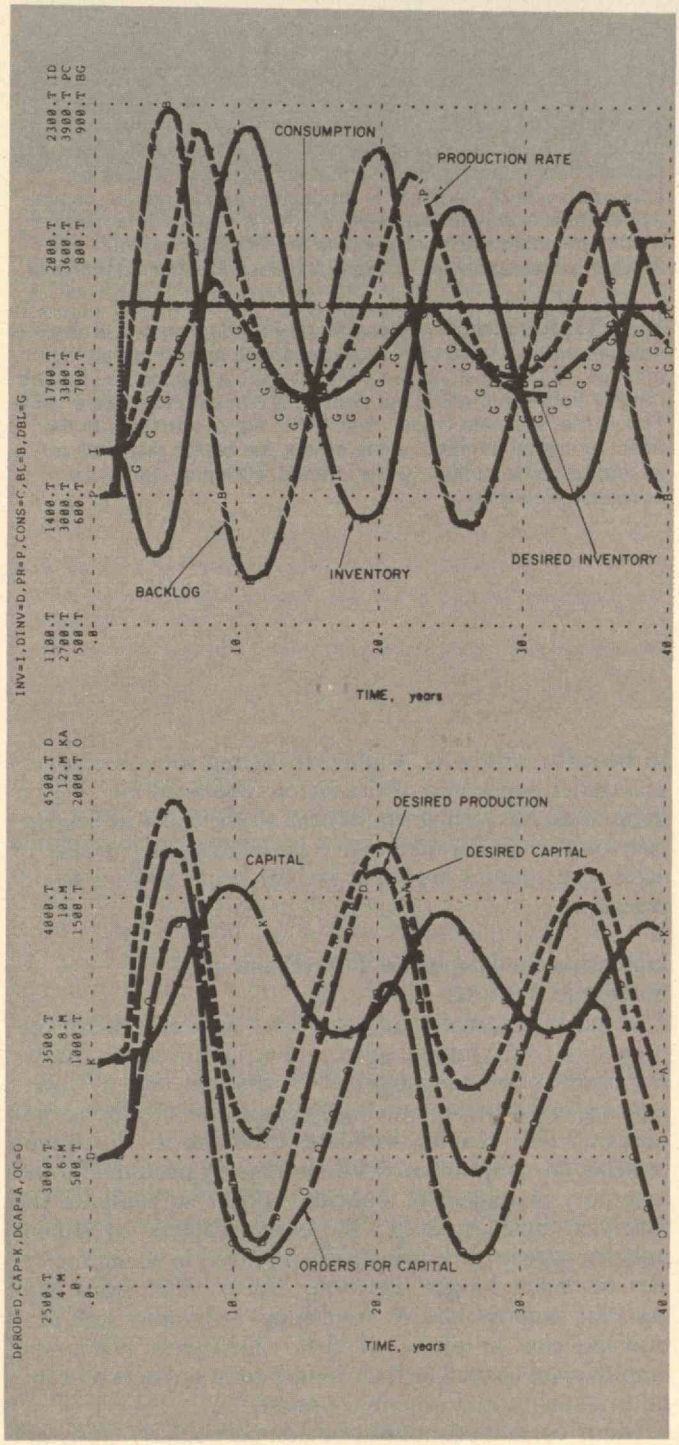
Cycles Induced Jointly by Labor and Capital

The previous simulations dealt with capital and labor individually; their purpose was to isolate the cyclical modes arising from each factor of production. Now we report a simulation which combines labor and capital in a joint production process. Our question was, "When capital and labor are combined, do the periodicities associated with each input factor remain distinct or are they mutually entrained to yield a single cycle of intermediate length?"

The chart on page 50, which plots fixed capital stock, labor, and production rate over a 100-year period, clearly illustrates the different periodicities associated with labor and fixed capital; these results are in accordance with the analyses discussed previously on models containing single factors of production. The results lend further support to the hypothesis that labor adjustments principally underlie short-term business cycles and that fixed capital investment is not an intrinsic factor in generating business cycles.

The studies reported thus far utilized a production sec-

These charts show the effect of the sudden increase in consumption shown in year 2 upon various components of the production-sector model shown on page 44, with capital the only variable factor of production. The cyclical performance of the economy seems to resemble that which occurred with labor as the variable, but the time scale of the cycles is very different: these charts span 40 years (instead of ten) on the horizontal scale. The author associates this simulation with the 20-year "Kuznets Cycle."

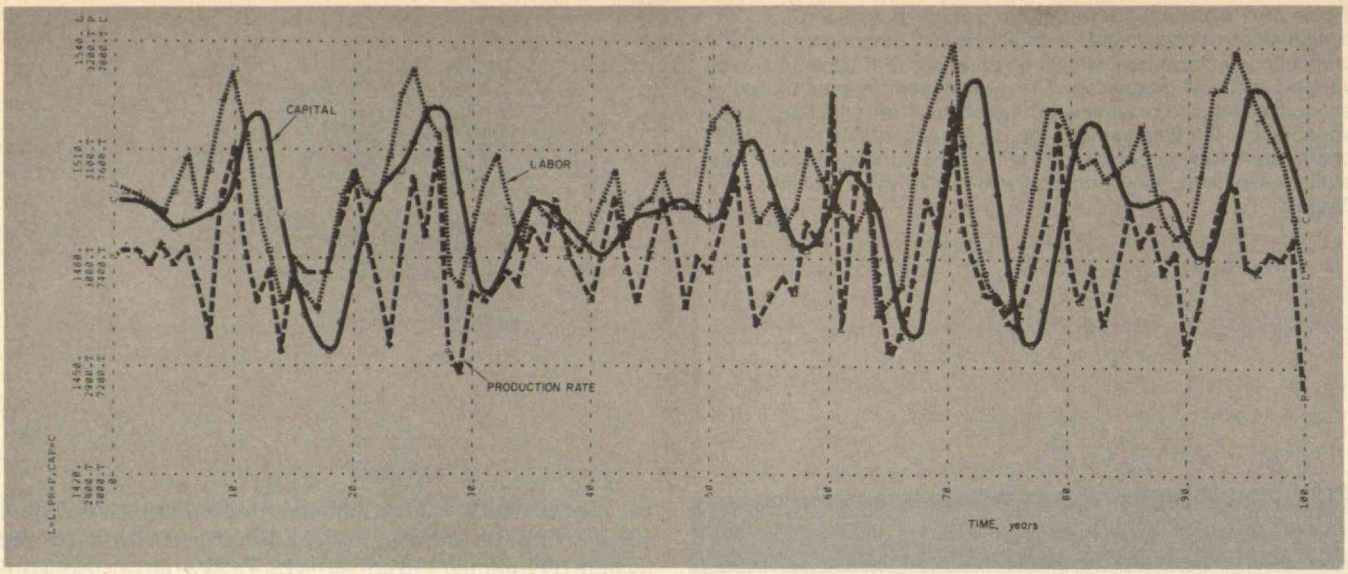


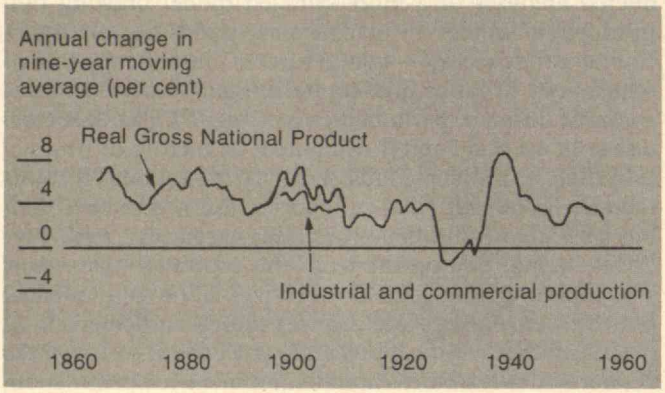
tor model which is a simplified component of a national socio-economic model now under construction by the System Dynamics Group at M.I.T. We have also conducted analyses of a more detailed model utilizing two production sectors — a consumer-goods sector and a capital-goods sector — which further illustrate the role of adjustment in labor and capital in generating economic cycles of different periodicities (*see page 51*). Both sectors utilize labor and capital equipment as factors of production. The consumer-goods sector of this model receives labor from outside (that is, labor is assumed to be available with a constant delay in filling vacancies), and it receives capital equipment from the capital-goods sector. The capital-goods sector also receives labor from outside, but the sector orders and receives capital equipment from itself. In other words, if the aggregate capital sector of the economy desires more capital equipment for production, it can acquire that capital equipment only by producing it within the sector.

When the capital and consumer production sectors are coupled, the capital-goods sector responds to a small (10-per-cent) one-time increase in the order rate for consumer goods with an irregularly-shaped (nonsinusoidal) fluctuation of approximately 50-year periodicity. The most basic cause of this 50-year cycle is the overshoot of production which occurs because of depleting output inventories and rising order backlogs in the capital-goods sector. Thus, for example, in the face of rising demand for consumer goods, the consumer-goods sector must order additional capital equipment from the capital-goods sector in order to expand output of consumer goods. The resulting increased demand for capital goods causes overshoot of capital production according to the mechanisms described in detail earlier.

However, the production-sector model now embodies the additional characteristic, not examined in the earlier simulations, of the capital-goods sector ordering capital equipment from itself. As the demand for equipment in the consumer-goods sector rises, the capital-goods sector must expand output. But to expand, the sector itself requires additional capital equipment. Consequently, the capital-goods sector begins to expand its orders for capital equipment, thereby filling the order backlog of the sector still further. The model thus demonstrates a mode in which incentives for expansion of the capital-goods sector motivate additional orders for capital equipment which, in turn, justify further expansion of the sector.

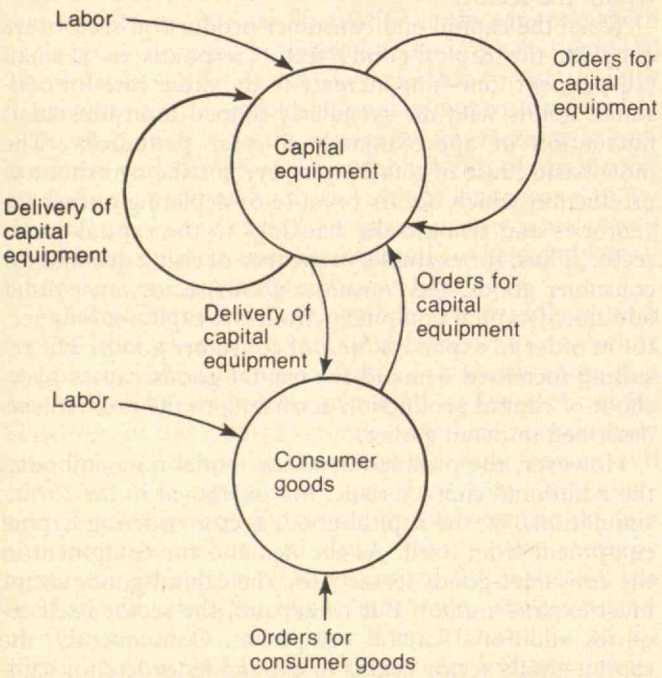
Although grossly simplified, this discussion explains in general how expansion of the capital-goods sector tends





To simplify the analysis, the author first used simulations of the production sector dealing individually with the impact of labor and capital; labor adjustments to higher consumption yielded a four-year cycle of instability in production and inventory, capital adjustments a 20-year cycle. Here are the results for a model in which both labor and capital inputs are variable; the four- and 20-year cycles attributed to labor and capital remain identifiable.

Though U.S. industrial and commercial production and gross national product have both shown absolute growth throughout most of the U.S. history, the per cent annual change has ranged roughly between 0 and 8 per cent on a 20-year cycle since 1860. This is the "Kuznets Cycle," which the author attributes to the effect of capital demand as the production sector responds to increased consumption. (Chart: Bert G. Hickman, *American Economic Review*)



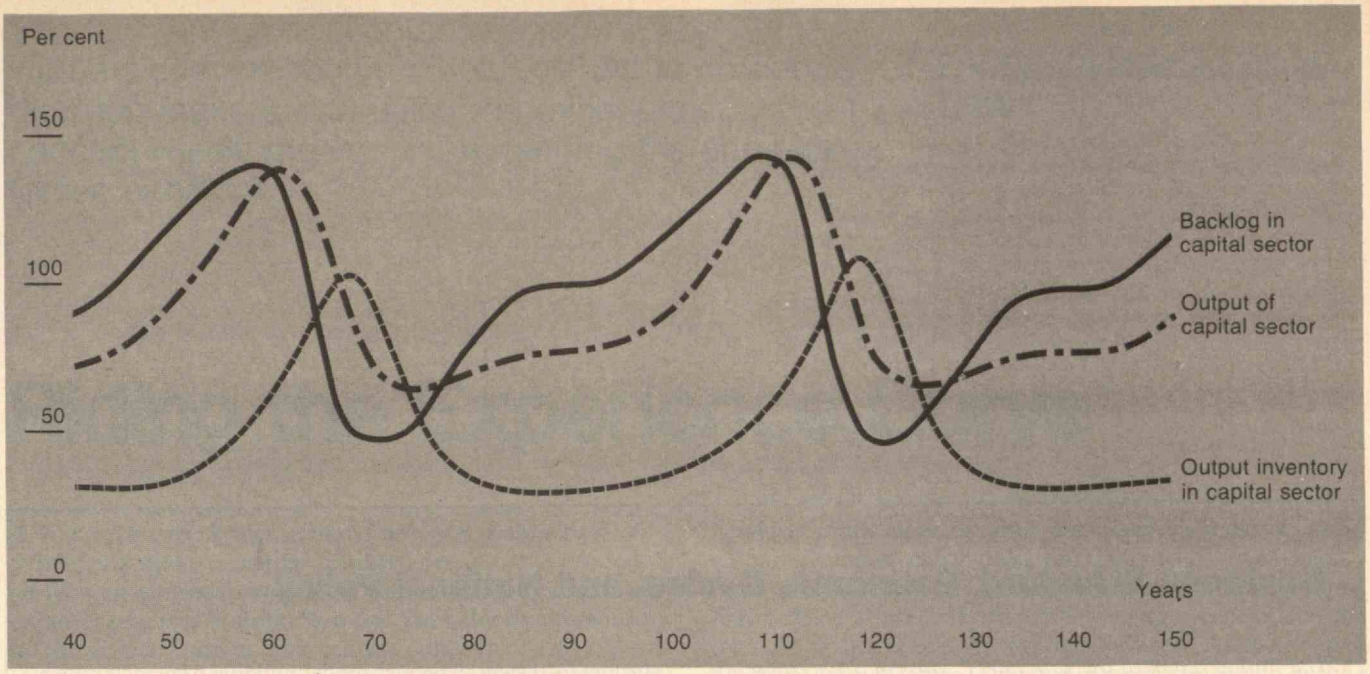
Thus far, the author's work has dealt with the simplified production-sector model shown on page 44. Now he adds an element of sophistication by interconnecting two production sectors — consumer goods and capital goods. As consumer demand increases, the consumer-goods sector demands new equipment from the capital sector, and that sector itself feels a two-fold pressure to expand to meet new consumer sector demand and to meet its own needs for more equipment.

to be self-reinforcing, leading to strong successive over- and under-expansion of the sector. The resulting 50-year fluctuation has strong similiarities to the classical description of the Kondratieff wave in which sharp peaks in economic activity are separated by broad valleys of depression.

Increasing the Scope and Time Frame of Economic Analyses

The work reported here represents a new, general approach to analyzing the sources of economic cycles, drawing upon a general model of production activity interrelating inventories, backlogs, acquisition of inputs, and output. The results indicate that labor-adjustment policies, in conjunction with short-term production and inventory-management policies, appear to underlie the four-year business cycle. Moreover, capital investment policies appear to be principally involved in economic cycles of much longer duration. These conclusions suggest the importance of analyzing economic stabilization policies in terms of their short-term effects on employment as well as their longer-term impacts on capital investment and potential output.

Many current economic policies, particularly monetary



As the model at the lower left of the facing page shows, demand in the capital-goods sector is self-reinforcing. A one-time increase of 10 per cent in the order rate for consumer goods results in higher demand for capital by the producers of consumer goods, causing depleted inventories and rising backlogs in the capital-goods sector. These falling inventories and rising backlogs in turn cause increased demand on the part of capital producers for capital and other factors of production. The resulting magnification of the demand for capital eventually induces cyclical overproduction on the 50-year cycle shown above. The author believes this behavior is associated with the "Kondratieff Cycle" in prices, interest rates, and capital investment.

policies, are largely predicated on a capital-investment theory of business-cycle behavior. However, if business cycles are attributable for the most part to short-term employment and inventory decisions, policies that focus on controlling fixed capital investment may have relatively little leverage for stabilizing the economy. Morever, if variations in fixed capital investment generate cycles of 15 to 20 years (or longer) in capital plant, policies designed to regulate capital investment can have significant long-term impacts on output, employment, and productivity.

In this light, further study using the production-sector model offers a new opportunity for more detailed examination of how capital investment policies produce long-run cycles of growth and depression, and how alternative policies might alter the long-wave behavior.

Indeed, we believe that a wide range of economic processes can be analyzed within the framework of the production-sector model described here. For example, extending the model to include a simple monetary sector may help to clarify the role of money and interest rates in business cycles. Detailed analysis along these lines should strengthen the foundations of business-cycle theory and, as a byproduct, improve stabilization policy.

Suggested Readings

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Kondratieff, Nikolai D., "The Long Waves in Economic Life," *Review of Economic Statistics*, Vol. 17 (Nov., 1935), pp. 105-115.

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Nathaniel J. Mass, who received his doctorate under Professor Jay W. Forrester in the Sloan School of Management in 1975, is Director of the Systems Dynamics National Modeling Project at M.I.T. The research reported in this article, which constituted Dr. Mass' doctoral thesis, was supported under a grant of the Rockefeller Brothers Fund; a fuller discussion is available in his book, *Economic Cycles: An Analysis of Underlying Causes* (Cambridge: Wright-Allen Press, 1975).

Business Structure, Economic Cycles, and National Policy

The studies reported by Nathaniel J. Mass in the accompanying article are an early result of a system dynamics model of the national economy now being assembled by Jay W. Forrester, Germeshausen Professor in the Alfred P. Sloan School of Management at M.I.T., and his colleagues and students. The following are excerpts from a description of the program by Professor Forrester for the 17th annual meeting of the National Association of Business Economists, Boca Raton, Florida, in October, 1975:

A method new to economic analysis is now being applied to examining social and economic change at the national level. The "system dynamics" approach had previously been developed as a way to relate corporate policies to their resulting behavior, such as growth, employment stability, and changes in market share. A system dynamics model is very different from the more common econometric models by being drawn from a much broader information base, by representing more generally the nonlinear character of real life, by containing a deeper internal substructure of policies, by including social and psychological variables as well as the strictly economic variables, and by having the objective of choosing between alternative policies for achieving long-term improvement of the system rather than the objective of short-term forecasting as a basis for current decisions.

In constructing a system dynamics model, one draws heavily on the knowledge of structure and policies already being used by managers, political leaders, and the public. From the available wealth of information, some already available in written and numerical form but much drawn from experiences and observations residing in people's heads, a computer simulation model is constructed. The computer model plays the roles of the separate parts of a social system according to knowledge about corresponding parts of the real system. A good system dynamics model can be related at every point in its structure and policies to corresponding knowledge about parts of the actual system it represents. In operation, the model should reproduce the same modes of behavior seen in the actual system and should exhibit the same kinds of successes, failures, and problems.

From the model, which is a captive replica of the actual system, new insights emerge about causes of behavior and the effectiveness of alternative policies.

Such a model for social and economic change in the United States is now partially assembled. It is being constructed according to system dynamics model-building principles which include:

a. Decision-making within each sector is modeled on widely observed business and government practice. (It is not based on a theory of "optimal economic equilibrium.")
b. Special attention is given to accumulations — reservoirs or buffers — such as inventories of inputs and finished stock, employee pools, bank balances, accounts payable, and order backlogs. Such accumulations decouple rates of flow from one another and thereby make it possible to model changes that occur in economic activity when rates of flow are out of equilibrium.
c. Highly nonlinear relationships that exist in reality are incorporated. Much of the information we possess about the actual economic system relates to limiting conditions, ultimate consequences of maximum pressures, and physical restraints on action. Such nonlinearities have a profound effect on behavior and must be incorporated if a model is to be realistic.
d. Quantitative computer simulation is used to derive the qualitative behavior of the system, that is, to discern the various possible modes of behavior and how they can be influenced by changes in policies at various decision points within the system.

Model development is still underway. But already, most sectors have been individually formulated and are under test. Sub-assemblies with various arrangements of multiple sectors have been examined.

Even at the present partial assembly stage, behavior is seen that raises important questions about current economic policy. The discussion in [Professor Mass'] paper focuses on economic fluctuations that are implicit in the structure of the production sectors of the economy. These observations, if correct, have major implications for government and business decisions. Even a small probability of their validity justifies priority for further analysis. The System Dynamics National Model summarized here should explain the existence and simultaneous interaction of the major modes of aggregate economic activity.

As we continue the model assembly, a deeper and more comprehensive understanding should emerge for how the economy behaves in the short, intermediate, and long run. We believe there can emerge a new tool to aid in developing more successful corporate strategies and more effective governmental policies for responding to present social and economic stresses.

The fact that production costs drop rapidly with experience can be a valuable aid to corporate decision makers. But using the experience concept wisely means understanding the complex forces behind it.

David L. Bodde
Energy Systems Group
TRW

Riding the Experience Curve

A Roman proverb has it that "practice makes perfect." While this claim remains unsubstantiated, the evidence clearly shows that experience improves things, and the experience curve is nothing more than the quantification of this improvement. The central concept of the experience curve is that the cost to manufacture a given item drops in a regular and predictable way as the total quantity made increases.

The real source of the experience effect is organizational improvement. Although learning by individuals is important, it is only one of many sources of increased efficiency — and one that is quickly exhausted. Changes in production methods, in administrative organization, and in the product itself account for much of the experience-related improvements.

The experience curve is usually charted by taking the *doubling* of output of a product as the unit increase in quantity. Then, the unit cost after doubling is expressed as a percentage of the cost before doubling. So, an 85 per cent curve would mean that the cost of the fourth unit of a product produced is 85 per cent that of the second; the eighth is 85 per cent that of the fourth; the one hundredth is 85 per cent that of the fiftieth; and so on. A typical experience curve, for the Ford Model T, is shown on page 55. The three basic features of the experience curve graph tell a lot about the process itself.

First, the horizontal axis measures the cumulative quantity produced on a logarithmic scale. This indicates that many doublings of cumulative production can be achieved early on. But as the product matures, vastly larger quantities are required to double the cumulative volume. This implies that the rate of progress down the experience curve, measured over time, will slow. Certainly, increasing annual volume can offset this, but exponential growth in volume is not sustainable in the long term, usually due to technical obsolescence of the product or market saturation. Thus, one should expect a slowing of the time rate of progress. The Model T case is typical of this.

The vertical axis of the experience curve, usually cost-per-unit or some other productivity measure, is also logarithmic. This means that the improvement per unit in absolute terms becomes quite small far down the experience curve. Thus, each increment of progress down the experience curve not only takes longer than the one before, but also yields less.

Finally, the experience curve as summarized above is phenomenological in nature. It portrays a relationship between cost and production volume which can, but not necessarily will, exist.

Many manufacturers find the experience curve an invaluable management tool. For instance, Texas Instruments has based its competitive strategy on maintaining a high market share and benefits from experience effects for over 20 years. TI recognized that industry prices for such products as integrated circuits would probably decline with cumulative volume, which the experience curve on page 56 (top) bears out. Declining industry prices imply that the costs of the circuits to individual companies must also drop. Assuming that all competitors follow a similarly shaped experience curve, the company with the largest market share will have the greatest cumulative volume and hence the lowest cost for its products. The graph on page 56 (center) shows how three hypothetical companies might be affected by experience. With different cost positions based on cumulative volume, one might break even, one might be marginal, and one might make money. But the experience curve is not a law of Nature. To make this phenomenon a reality, managers must understand:

— The forces which make the experience curve operational
— The experience curve's limitations, and
— The curve's implications for the manufacturing strategy of the firm.

First, I will discuss the forces underlying the experience curve phenomena. These complex, interrelated forces permeate the entire fabric of a company.

Labor Efficiency

Labor's contribution to the experience curve effect was discovered by aircraft manufacturers prior to World War II. Studies of airframe production then revealed that fighters, bombers, and transport aircraft all showed a common experience curve of about 80 per cent. Further investigations showed that those manufacturing operations which were similar in labor content tended to have similar experience curves. Naturally, many observers have concluded that the experience effect is related to people. As workers repeat a particular production task, they learn improvements and shortcuts which increase their collective efficiency. The greater the number of worker-paced operations, the greater the amount of learning which can accrue during a particular production run.

Historical data show that about three-fourths of the direct labor in airframe manufacturing is in assembly. The remainder is in machine work. This pattern seems to hold for most types of aircraft. The result is a largely worker-paced operation with an 80 per cent experience curve. But

The sharp drop in price of the Ford Model T as manufacturing improved represents a typical experience curve. The logarithmic scales indicate graphically that the experience curve for a product begins rapidly, but slows as the limits of expansion and of the product are reached. (Data: Abernathy and Wayne — see *Suggested Readings*)

when the proportion of the machine work increases to one-half, the downward slope of the typical curve is not so steep — about 85 per cent. If the ratio is about one-fourth assembly and three-fourths machine work, the slope goes up to about 90 per cent.

However, this learning effect goes beyond the labor directly involved in manufacturing a product. As a process matures, maintenance personnel also become more productive, supervisors are better able to recognize and eliminate sources of waste and inefficiency, and persons in line and staff positions increase their productivity. In short, the collective efforts of many persons throughout the firm result in the performance of a common task with increasing efficiency.

Growing labor efficiency does not accrue automatically. The personnel policies of the firm must be designed to encourage it. Achieving learning effects seems to depend on effective management in three areas — workforce stability; compensation; and the organization of the workforce.

High quality and stability in the labor force are essential to achieving learning effects. Without high quality and stability in the workforce, planned cost reductions can evaporate, as shown by the DC-9 program of McDonnell Douglas Aircraft:

The firm, then Douglas Aircraft, planned the production and pricing of the DC-9 in 1963, when there was considerable slack in the U.S. economy. At that time, some 10,000 skilled and semi-skilled workers were unemployed in the nearby Los Angeles area. But by 1966 the picture had changed. Orders for the DC-9 were much higher than expected, and an upturn in the economy drew down the available labor force. As a result, Douglas was forced into a massive training program involving many marginal workers who soon quit or were fired. From the beginning of 1965 until mid-1966, the aircraft division hired 34,703 persons, but lost 12,024. As a result, the anticipated 85 per cent learning curve was not attained. Since the pricing of the DC-9 had been based on expected learning curve economies, the profitability of the firm was seriously eroded.

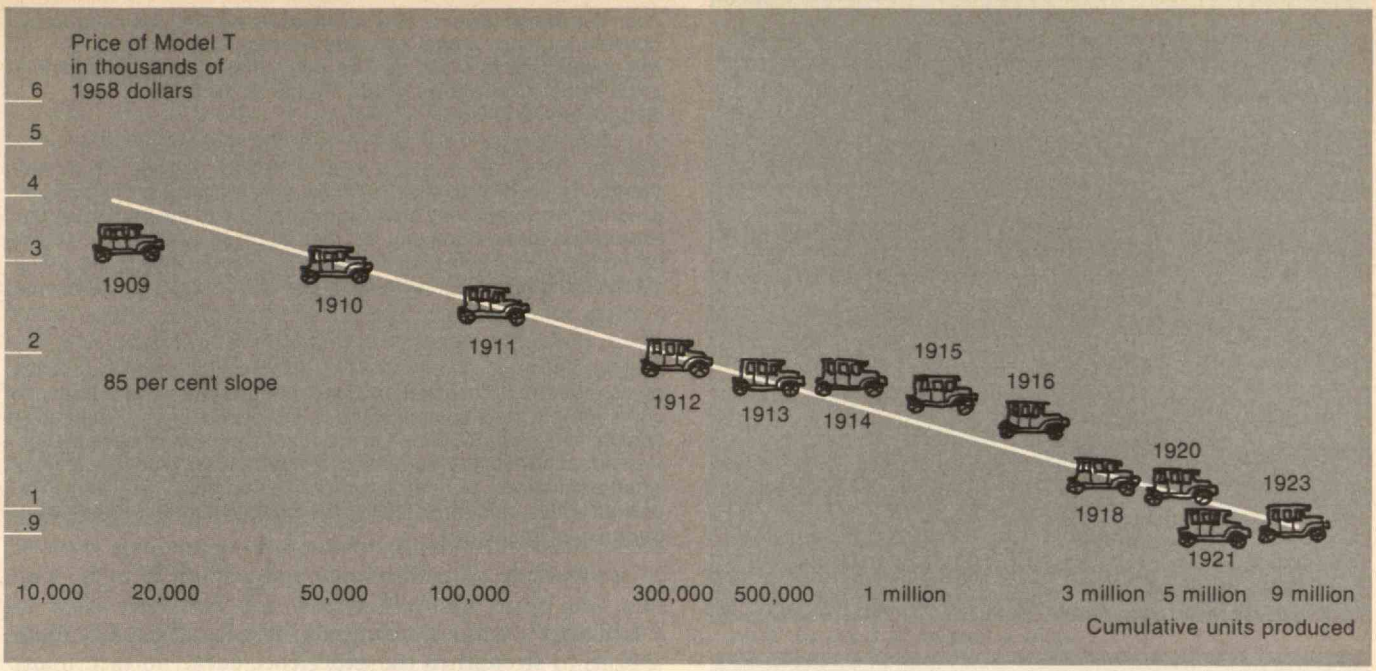
The *compensation plan* of the firm can also be an important influence on the experience curve. Too frequently, wage incentives are applied in a way that acts as a strong negative motivator for the workers. Employees can become demoralized over the ultimate performance levels expected of them to maintain historical pay rates. Or, the labor force may use its influence on productivity to "bargain" informally for greater pay at a given level of effort.

For instance, a study by Nicholas Baloff of Stanford University indicates that the steel industry often used wage incentives to boost worker productivity. One steel company adopted an incentive plan as a means of compensating the operating crew of a new steel-making process. During the first four months of the new operation, these workers were paid based on their past average earnings. As the graph on page 56 (bottom) indicates, productivity rose, at least initially. But at the end of the fourth month, management installed a permanent wage incentive plan which raised the productivity standards for the workers. Labor dissatisfaction with the incentive became apparent very quickly. After one month of experience with the new plan, productivity fell sharply and remained at about 70 per cent of the previous level.

The graph on page 59 illustrates how workers can also use their leverage on the experience curve to bargain informally for higher earnings. The experience curve estimated by this steel company for a new process was far different from the actual production history. As in the previous case, compensation was first based on past average earnings, and initially worker productivity surpassed management expectations. But when the permanent incentive plan was installed, productivity growth ceased. Professor Baloff attributes the change to worker dissatisfaction with the new pay scheme. The "incentive" was in reality a disincentive, presumably because the production increase required per pay increase was so high. For ten months productivity remained virtually constant. The firm, anxious to meet the rising demand for steel, was forced to lower the incentive standard required for higher pay. The immediate and significant jump in productivity which followed indicates how much the operating crew could withhold productivity to bargain for a higher incentive rate.

How can a manufacturer design a compensation system to stimulate experience curve economies without alienating the workforce? One method, a sharing of cost savings, has been widely hailed, but only rarely put into practice.

Kaiser industries installed the cost-savings-sharing plan at its Fontana, Calif., plant after withdrawing from an industry-wide collective bargaining group during the marathon steel strike of 1959. Kaiser signed a separate agreement with the United Steel Workers Union (U.S.W.) and set up a committee to plan for "equitable sharing of the fruits of the company's progress." After years of study, the result of this effort, the Long Range Sharing Plan, went into effect in March of 1963. In brief, the plan



called for Kaiser to pay one-third of its savings in labor and material costs to the workers. The savings were computed on a 1961 base under a complicated formula which averaged costs over a six-month period to avoid sharp fluctuations. The worker payments were divided between monthly cash payments and a wage and fringe benefits reserve fund.

By 1967, this plan had largely achieved its major goal — the elimination of work stoppages. This was important to Kaiser in the early 1960s. Then the company had just completed a major expansion, and had relatively high fixed costs. It needed production to cover those fixed costs as well as to take advantage of the newly-installed steel-making technology.

In addition, the savings sharing plan reduced the number of workers on other incentive schemes which Kaiser had considered expensive and inequitable. Productivity growth and savings in material costs under the new incentive plan have been satisfactory. While there have been some complaints about declining payouts, both the U.S.W. and Kaiser apparently feel that they have benefited from the plan.

If savings sharing is so good, why has it not been widely adopted? According to the U.S.W., a cost savings plan works best in a single-plant company on the verge of installing new process equipment. In that setting, it offers management reduced costs as experience accumulates. But beyond this, the benefits of savings sharing have not been widely explored.

Finally, *new forms of workforce organization,* now beginning to appear on the industrial scene, can affect the experience curve. Work restructuring experiments have taken place at such firms as General Foods (Topeka, Kansas plant), Proctor and Gamble (Lima, Ohio plant), Alcan Aluminum (smelting plant in Quebec), Shell Oil (refinery in England), and Volvo (auto assembly plant in Kalmar, Sweden; see December *Technology Review,* p. 17). These radical departures from the prevailing work organization have emphasized self-managing work teams which assume collective responsibility for large segments of the production process.

Data gathered by Professor Richard E. Walton of the Harvard Business School suggest that these experiments have been very successful. For instance, the Topeka plant of General Foods has been producing pet food since January, 1971. After 18 months of operation, the reductions in plant operating costs resulted in annual savings of $600,000. This derived from such improvements as a 92 per cent reduction in quality rejects and an absentee rate 9 per cent below the industry norm. The safety record was one of the best in the company, and worker turnover was far below average.

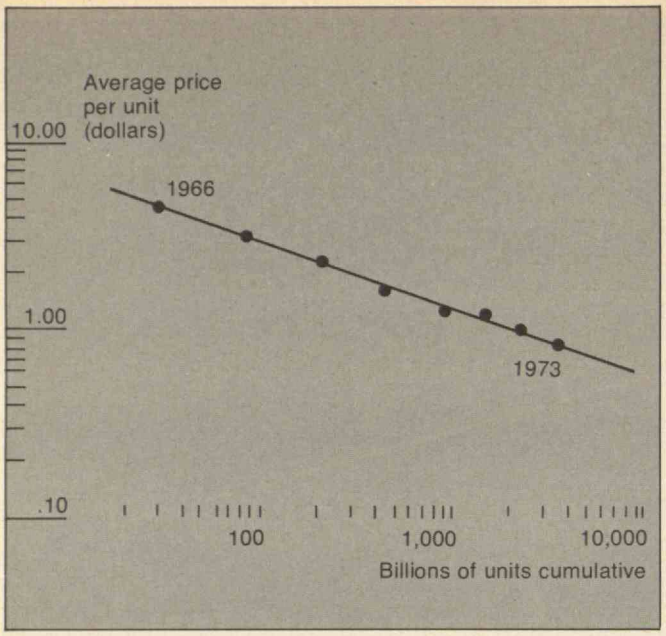
Even though there have been many apparent successes, it is not yet clear that work restructuring will help companies achieve consistent experience economies in the long term. Nevertheless, new methods of organizing the workforce could be quite influential in coming years.

New Processes and Improved Methods

Innovations and improvements in manufacturing can be a significant force behind the experience curve. This is particularly true of industries in which worker learning is a relatively minor source of economies. In such a case process innovations and/or substitution effects become much more important sources of cost reductions.

The electronic semiconductor industry presents an excellent example of process change. In this business, most of the experience effect stems from improved production technology itself. The times and temperatures used to prepare semiconductor crystals are optimized; there is better control of crystal contamination during fabrication; assembly and test equipment is improved; and so on.

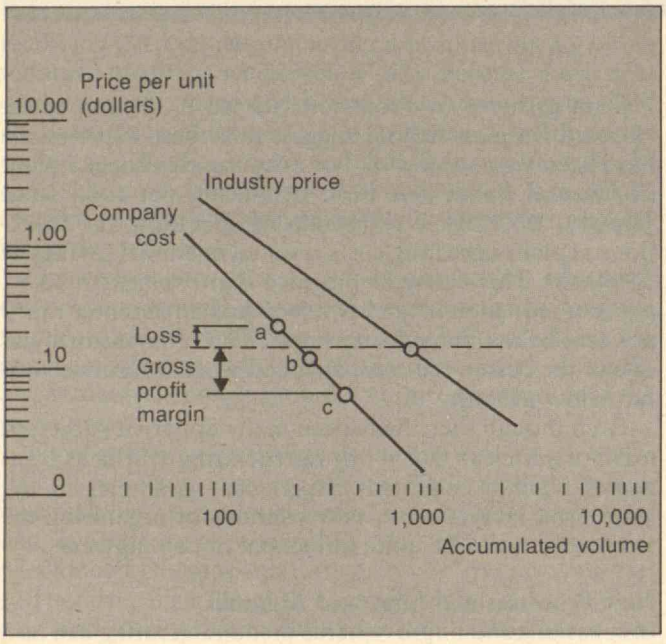
To bring about this sort of technological change, the semiconductor industry devotes a large fraction of its research and development to process improvements. Technical personnel study the production system and experiment with potential improvements. Top management constantly devotes its attention to realizing experience curve economies. As a result, strong experience curves of 70 per cent to 80 per cent are common in this industry, despite the absence of a powerful worker-learning effect.

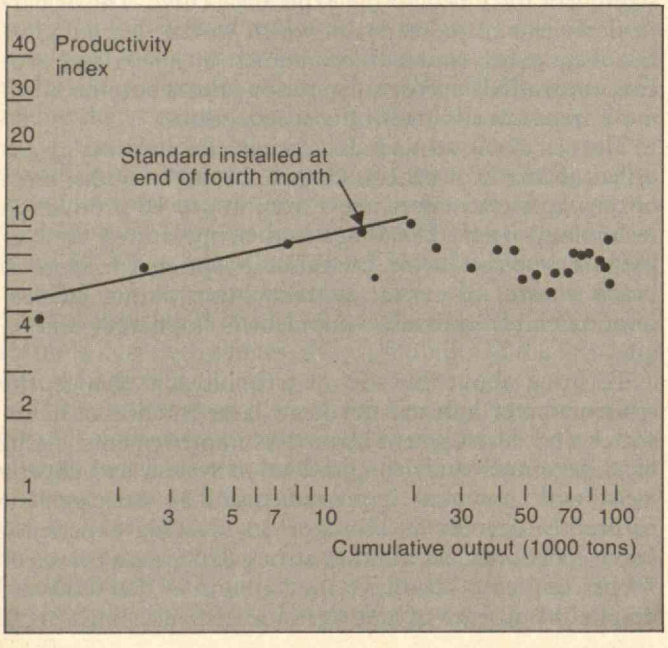


Top: Texas Instruments has successfully applied the experience concept for many years, correctly inferring that the costs of integrated circuits would decline with cumulative volume, as this experience curve shows. (Data: Texas Instruments — see *Suggested Readings*)

Center: Three companies may show very different profit-margins, according to where they stand in relationship to the market on the experience curve. Company "a," well along on its experience curve can make a profit selling at the going rate; company "b" will break even, and company "c" will lose money. (Data: Texas Instruments)

Bottom: Success in making the experience effect a reality depends on an effective compensation plan for employees. The experience curve for this steel company shows the effects of an ill-conceived compensation plan. During the first four months of a new operation a standard pay scale was in effect and productivity rose. However, when productivity standards were raised unrealistically high in a new incentive plan, productivity fell sharply. (Data: Baloff — see *Suggested Readings*)





Changes in process technology need not be major innovations to strengthen the experience curve. In fact, many are so unimportant that they pass virtually without notice. The evolution of the commercial airliner, the basic process element of the airline industry, is a good example. From the DC-3 of 1936 until the introduction of the turbine-powered airliners in the 1950s, no major innovations can be discerned in the commercial airliner's basic design. But during this period, the operating cost of carrying a passenger dropped some 50 per cent. This decrease has been attributed to a series of incremental innovations which stretched and advanced the fundamental DC-3 concept.

Thus, the cumulative effect of such minor innovations can be both significant and widespread, despite their incremental nature. The airline industry is certainly not the only one to benefit from experience effects of technical change. The operation of petroleum refineries, nuclear power plants and steel mills are among the most widely cited examples.

Effects of Substitution in the Product

Manufacturing is typically characterized by trade-offs among an immense variety of alternatives. As experience accumulates, the producer can often incorporate cheaper materials or less expensive processes into his product line. Trade-offs between high- and low-cost components become possible. The Boston Consulting Group has suggested that trade-offs among such cost factors as research and development, advertising, and automation may account for a significant part of the experience effect.

Technical Conservatism and Product Redesign

A company's process equipment itself is often designed quite conservatively, such that the user can often achieve experience economies in its use. Designers often allow very conservative performance margins to insure that they achieve the rated capacity of a piece of process equipment. Thus, as experience accumulates, the user of such a piece of equipment can obtain performance in excess of rated capacity. This effect has been observed in fluid catalytic cracking units used in refining oil. These units often "grow" to about 150 per cent of designed capacity over a ten-year period.

However, two caveats must be observed here. First,

sub-systems not considered critical to the rated capacity of a plant may not have high performance margins. These may develop into bottlenecks which must be eliminated to take full advantage of the remaining margins. Second, the producer of such plants may use his own experience in design to reduce performance margins in later models. Thus, product redesign adds to the producer's experience curve effect but not the user's.

In general, product redesign can be an important source of experience curve economies. As a product matures, both its manufacturer and its customer gain a clearer understanding of the performance required of the product. Once these performance expectations are met, the product can be redesigned in order to conserve material, allow greater efficiency in manufacture, and substitute less costly resources for expensive ones.

Standardizing the Product

Product standardization is also a force behind the experience curve. Without some standardization, the replication of tasks necessary for worker-learning could not take place. Likewise, process innovations need a reasonably fixed target. However, the appropriateness of standardization varies with the maturity of the product. In the early phases of a product's life cycle, when flexibility is important, a high degree of standardization could be risky indeed. But during the growth phase, a highly standardized product can help meet production goals. Both the Ford Model T and the Xerox 914 copier, for example, represent strategies of deliberate standardization to achieve desired cost and production levels.

But as a product matures, market segmentation can become an appropriate strategy. A single standard product may be inadequate in the face of competition, and the product line typically widens. But a wide product line complicates the production task. It can reduce the ability of a firm to focus manufacturing operations on the key aspects of competitive success. Information processing channels can become overloaded as the complexity of the workflow increases. One way to alleviate this is through changes in the way production is organized. Another way is through modular standardization.

Modular standardization became prevalent in the auto industry in the late 1950s, according to research by Professor William J. Abernathy of the Harvard Business School. For instance, at Ford, distinctive engines for particular car lines were discontinued in 1959, and all Mercury engines were dropped. Engines became standardized modules which were applied across the product line to autos of appropriate weight. As a result, engine plants at Ford became highly specialized and automated. Long production runs made experience curve effects possible, while modularity enabled the company to offer the variety that sells cars.

Using Economies of Scale

The effect of static economies of scale on the slope of the experience curve is probably small in most cases. To be sure, it is possible to envision circumstances under which scaling up a process can increase the *volume-rate* of improvement. But evidence also exists, as we'll see later, which warns of an opposing effect. The inflexibility which can accompany a large-scale manufacturing process could reduce the firm's capacity to pursue the changes necessary for continued improvement.

Nevertheless, scale is important to the *time-rate* of improvement. A large-scale process allows a greater increment to cumulative volume in a given time-period than a small-scale process. The firm with high-volume manufacturing facilities will therefore not only achieve static economies of scale, but also will advance farther down the experience curve in a given time than its smaller rivals.

Building With Shared Experience

A common experience base — one root from which grows several products — can be an important source of economies, particularly in multi-product companies. Many products, such as petrochemicals, are indistinguishable until late in the production process. So a new product can often draw upon much of the accumulated experience of its fellows.

Identifying shared experience has ramifications for strategy as well as cost. By focusing new product efforts on areas where common experience plays a major role, the firm builds diversity upon strength, and can get an early cost advantage over competitors.

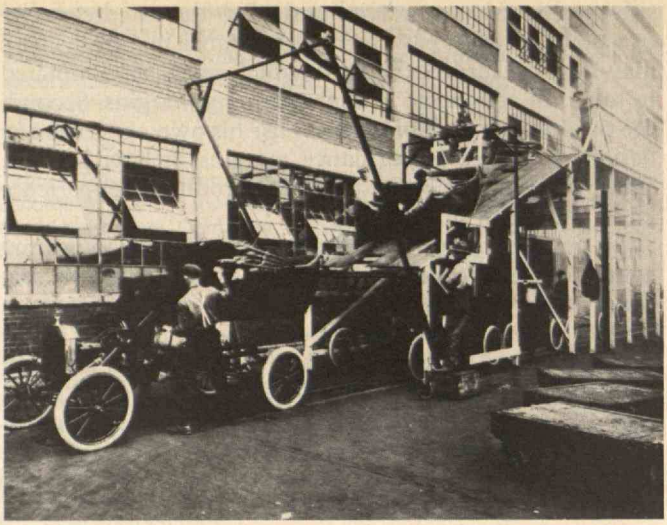
Limits to the Experience Curve

Most evidence suggests that the experience curve does not give the manufacturer an endless ride down an ever-descending cost path. For one thing, product obsolescence may make the experience curve irrelevant long before its lower limits have been fully explored. For another, the inflexibility which often becomes endemic far down the experience curve can inhibit the technical changes and substitutions needed for continued cost reduction. Perhaps the best example of this is the experience of the Ford Motor Company with the Model T, as documented by Professor Abernathy and Kenneth Wayne.

By the 1920s the Model T had evolved into a highly standardized product, as a consequence of Henry Ford's pursuit of his cost-minimizaion strategy. This strategy was a spectacular success, at least initially. As a result of productivity increases, prices fell regularly from more than $3,000 in 1908 to less than $1,000 in 1926, and Ford dominated the market for most of this period. To achieve these productivity gains, Ford adopted specialized manufacturing technology. He acquired companies which supplied raw materials such as steel or lumber, as well as a railroad to haul these materials. By the 1920s, the Ford Motor Company had become a giant, integrated machine for turning raw resources into Model T's. But the inflexibility inherent in a thoroughly standardized product and vertically integrated manufacturing process carried with it the seeds of later trouble.

In the early 1920s, consumer demand began shifting. Used cars were becoming plentiful and met the need for cheap transportation. Ford was soon competing with his own used cars. New buyers preferred the heavier, closed-body automobiles which offered greater comfort. Unfortunately, the Model T was unsuited for adaptation to the closed body style. To compete with other auto makers, Ford had to add features to his standardized cars which began to negate the steady reduction in cost. But no amount of features could save the Model T, and by the mid-1920s, this venerable and obsolescing car was uncompetitive as an engineering design. Faced with changed consumer preference and the new, closed-body technology introduced by competitors, Ford ceased production in May of 1927.

Ford's blind pursuit of cost reduction had laid the



Ford Motor Company's first moving assembly line was located in Highland Park, Mich., in 1913. The Ford Model T benefitted from the experience curve for almost two decades, but an inflexible devotion to the Model T proved the company's downfall when the car became obsolete. (Photo: Ford Motor Company)

groundwork for its own demise. It had locked Ford into large capital investments in a fixed process for making an obsolete product. Change could be postponed, but it could not be averted. And when it came, the result was devastating: during the year required for the changeover to the Model A, Ford lost $200 million, replaced 15,000 machine tools and rebuilt 25,000 more, and laid off 60,000 workers in Detroit alone. After the Model T debacle, the role of market leader in the auto industry passed to General Motors.

The Experience Curve and Manufacturing Strategy

The experience curve is a long-range strategic rather than a short-term tactical concept. It represents the combined effect of a large number of factors which may undergo substantial fluctuations over short periods. As a result, it cannot be used reliably for operating controls or short-term decision making. But in the formulation of competitive strategy, the experience curve is a powerful instrument, indeed.

The experience concept as a tool for strategic decision making is based on a strong association among cumulative volume of production, market share, and profitability. An impressive array of evidence suggests that these variables coexist — that high cumulative volume, low costs, high market share, and high profits typically reside in the same firms.

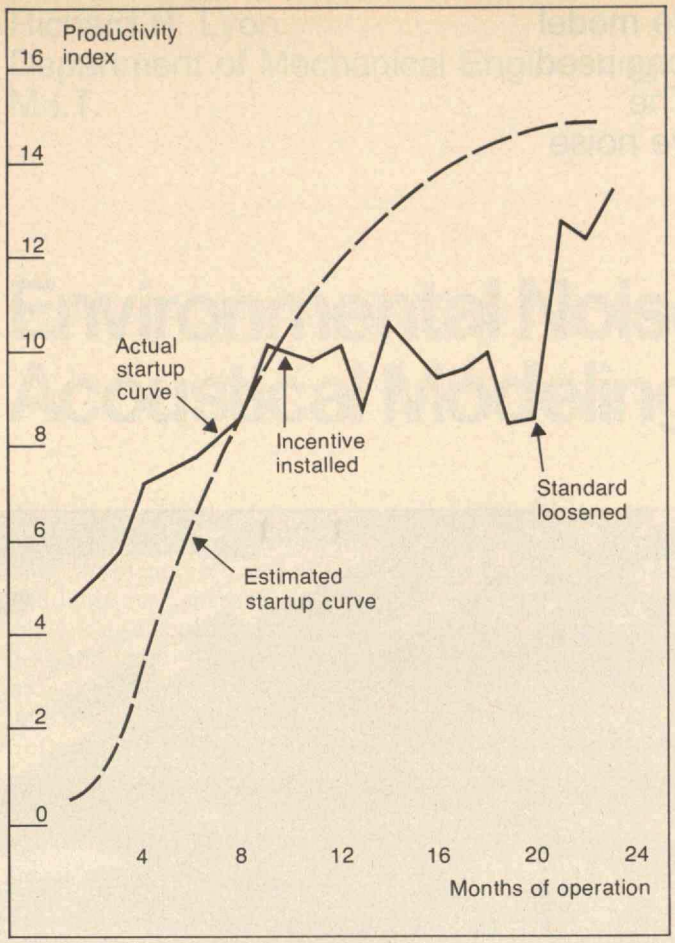
To be sure, experience might not be the only driving force behind all these associations. Market leaders also tend to have higher quality products than their competitors and to receive higher prices. Companies, such as Eastman Kodak and IBM, spend significantly higher amounts on research and development, relative to sales, than their rivals in pursuing a product leadership strategy. A commanding market share could therefore arise from higher quality products. Likewise, superior profitability could derive from the higher profit margins normally associated with high-quality products. This has been the critical factor in the success of Hewlett-Packard, manufacturer of sophisticated electronic calculators. It is thus important to assess product differences before attributing market share and profitability rankings mainly to experience.

Nevertheless, the experience effect seems to underly each of the basic product-market strategies which the firm might adopt. These strategies, as identified by Robert Buzzell, Bradley Gale, and Ralph Sultan of Harvard Business School, are:

— *Building Market Share.* Evidence suggests that there is a minimum market share needed for viability. Firms which have not attained this critical mass appear to have two choices: increase share or withdraw. RCA and General Electric apparently decided that they were below this minimum in the computer business and chose to withdraw rather than undertake the expense of building a larger share. Share building is also appropriate when the firm has achieved market viability but lacks sufficient market share to yield high returns. Firms undertaking this strategy should recognize that large increases in share are seldom achieved quickly, and that expanding share is always expensive in the short run. Some expense can be mitigated, however, if the share builder is able to concentrate on a market segment not addressed within that segment. For instance, Digital Equipment Corp. has concentrated on small computers, outselling IBM in that area.

— *Holding Share.* This strategy is designed to preserve the status quo and is common in mature industries. The key question here is what is the most profitable way to maintain market position. Holding is generally less costly than building due to the favorable position of the market leader on the experience curve. Thus, the established firms have a salient advantage. Companies can use this advantage to gain high profit margins by not reducing prices as rapidly as experience lowers cost. This increases short-term profitability, but also invites new entrants whose presence could erode the established firm's market share. Alternately, the experience advantage could be used to discourage new entrants if prices are reduced with declining costs. The putative rival must then make considerable short-term sacrifices to compete. Both policies, however, can have strong anti-trust implications.

— *Harvesting.* This means a company would allow market share to decline to maximize short-term earnings. In effect, management using this strategy "sells off" a portion of its market position for a higher short-term cash flow. In many cases a company adopts this strategy more from necessity than choice. The firm might urgently need cash to support dividends, the earnings record of its management, or another investment. But as market share declines, so does the potential for experience accumulation. Use of this strategy will depend on management's assessment of the direction and timing of future developments and its preference for immediate rather than long-term gain.



Workers can use their leverage on the experience curve to bargain informally for higher wages. In the steel company charted here, workers achieved an excellent startup curve for a new process, but held back when incentives were toughened, only to increase productivity again when standards were adjusted. (Data: Baloff)

Future of the Experience Curve

The gains in efficiency and productivity which come with experience can be important to national economic progress as well as to the betterment of individual firms. This importance is not likely to diminish, but future events could influence the *application* of the experience curve in subtle, yet far-reaching ways.

For one thing, the American economy may now be entering an era of long-term resource constraints — on materials, energy, and capital. In the past, the U.S. has been endowed with abundant resources, at least relative to the other western industrial nations. As a result, innovators have tended to focus on labor-saving improvements and the substitution of relatively abundant physical resources for relatively scarce manpower. But if resource costs rise relative to labor costs, this historical pattern could be reversed. In such a world, resource-saving technological changes might become the most important source of experience curve economies.

The changing expectations of the production workers themselves is another powerful force affecting the experience phenomenon. There is much evidence that workers increasingly desire challenge, personal growth, and influence on how things are run. It may no longer be viable to seek cost savings through the traditional pattern of work specialization and task simplification. Managers seeking to develop an experience effect will have to consciously address the rising expectations of the workforce to achieve the planned economies.

Finally, the experience curve may become significant in areas beyond the manufacturing context in which it is usually applied. For example, experience effects have been noted in the health care field, government operations, and many service industries. Unfortunately, our understanding of the forces which underlie the experience curve in the service sector is far from adequate, and little systematic data is available here. It is clear, however, that such an understanding will increase in importance as the service sector of the American economy grows.

Despite these far-reaching changes, one aspect of the experience curve concept is likely to remain constant — to apply it successfully managers will need an awareness of the multidimensional forces behind it and how these forces can be integrated into the total strategy of the organization.

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Shining high-frequency sound into a scale model of an auditorium or other room has been long used to aid design in architectural acoustics. The technique is now being used to help solve noise problems outdoors.

A 1:80 scale model of a Los Angeles Airport runway and the surrounding neighborhood allowed the author to study various methods of shielding communities from airplane noise.

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Environmental Noise and Acoustical Modeling

Reducing noise where we work and live is far from a simple task. There are the well-known economic and materials problems of constructing quieter machines and buildings. And there is the fact that noise often follows a devious and complicated path in penetrating home, business and factory. Conventional mathematical procedures for calculating the propagation of noise from its source to its destination cannot handle many of the complex situations that occur in real life. For the past five years at M.I.T. we have been learning to study noise propagation using physical scale models of such places as airport runways and city streets. By substituting a scaled-down physical replica for the real thing, we can study noise transmission in a situation that is easy to control and change. Even then modeling is not simple, however, for we must still know what we must replicate faithfully, and what we can ignore for the sake of simplicity and economy.

Acoustical modeling is not new; it has been used for many years for evaluating the acoustics of interior spaces, and to a degree, for exterior problems. The earliest scale models developed to understand the behavior of sound waves used shallow water waves in a "ripple tank" as the wave source. In such a tank, first used in the 1840s in Germany, an oscillating paddle produces a wave train which may be reflected and diffracted by a wall protruding from the tank bottom. Varying the depth of the water will change the speed of the ripples so that an underwater ridge will cause refraction and perhaps focusing of the waves. The wave can be absorbed by constructing a beach along the boundaries of the tank. When light is passed through the tank and onto a screen, the black lines corresponding to each ripple can be followed.

Spark shadowgraph/schlieren photography is another way to make visible the progression of wave fronts in a small model of an auditorium or other space. The spark emits a strong sound pulse which propagates through the model. Such strong sound pulses can be made visible because the high-pressure sound wave refracts light differently than the low-pressure troughs between the waves. A flash lamp triggered by the spark discharge provides a light source for a camera producing the shadowgraph picture, so named because of the shadowlike appearance of the waves. While the visualizations of sound produced by ripple tanks or spark shadowgraphs provide a "feel" for how sound waves propagate, they have little quantitative value, unlike the techniques developed in our laboratories.

The Basics of Modeling

Sound frequencies used in a scale model must be scaled *up* in the same ratio that the model dimensions are scaled *down*, if a scale model is to represent how sound behaves in the real-life situation. And, of course, the model itself must be geometrically similar to real life so that sound spreading, scattering and diffraction are properly reproduced in the model. The reflectivity of sound by objects in the model must also simulate the reflectivity of the real-life objects. The directivity and placement of sound sources (musical instruments, for example) may also have to be simulated to get the proper distribution of sound levels in the space.

Even all this precision is not enough. To simulate the audible qualities of a space fully it is necessary to preserve the subtle variations in sound phase and amplitude caused by diffraction around a listener's head and upper body. Investigators in Germany have shown the effects of the head and body on sound by making remarkable binaural recordings using an artificial head, or "Kunstkopf." This is essentially a head and neck made of hard plastic or rubber, with microphones imbedded in the ears.

A group at the Technical University of Munich has developed an interesting technique with such an artificial head. The sound source is a speeded-up tape recording of music played into the model by specially designed high-frequency loudspeakers. Binaural recordings of sound in a scale model of an auditorium are made using the head. A listener can then replay this binaural recording and judge changes in the sound quality of the hall as the geometry of the space and locations of major absorbing and reflecting surfaces are changed. Thus, one can select the desired auditory qualities of a proposed space before it is built, and can choose various design options.

However, we need not bother with the niceties of binaural recordings in studying environmental noise. The impact of noise on humans does correlate well with its intensity, spectrum (frequency content) and time-variation of the noise. But subtleties in phase that are important in the appreciation of music seem to be unimportant in assessing noise. My group at M.I.T. began working with scale models early in 1971 to understand how noise penetrates into city streets from overflying aircraft. At that time, there was interest in the possible development of vertical- or short-take-off-and-landing aircraft ports near urban centers to provide better inter-city transportation. The idea looked promising; in one demonstration, a helicopter flew from Boston Common to Central Park in New York in one-and-a-half hours. But before such a

port could be built, we had to understand how the buildings would affect flyover noise; model studies appeared to be the way. After constructing models of urban canyons, we moved airjets over them measuring the noise levels, and comparing our results with similar flyovers of flat or open terrain. We compared these results with real life via a series of overflights of a Boston street by a helicopter, arranged through our sponsor the Department of Transportation, and the Office of the Mayor.

We also studied noise penetration into an overall urban area, by constructing a small-scale "city" of plywood boxes and "flying" a sound source along its edge at various altitudes. We compared resulting noise levels at a variety of locations with what they would have been in the absence of boxes. It turned out that sound is enhanced when it is channeled along a street, but some areas are shielded by the buildings. On the average the buildings may cause the levels to be greater than in open terrain, but only by a few decibels.

Answering Sound Questions

In the course of these studies, we began to discover that quite a number of basic questions about noise propagation were amenable to scale modeling:

— the effects of shape and materials on sound reduction provided by the barrier;

— how building roughness affects noise propagation along a street;

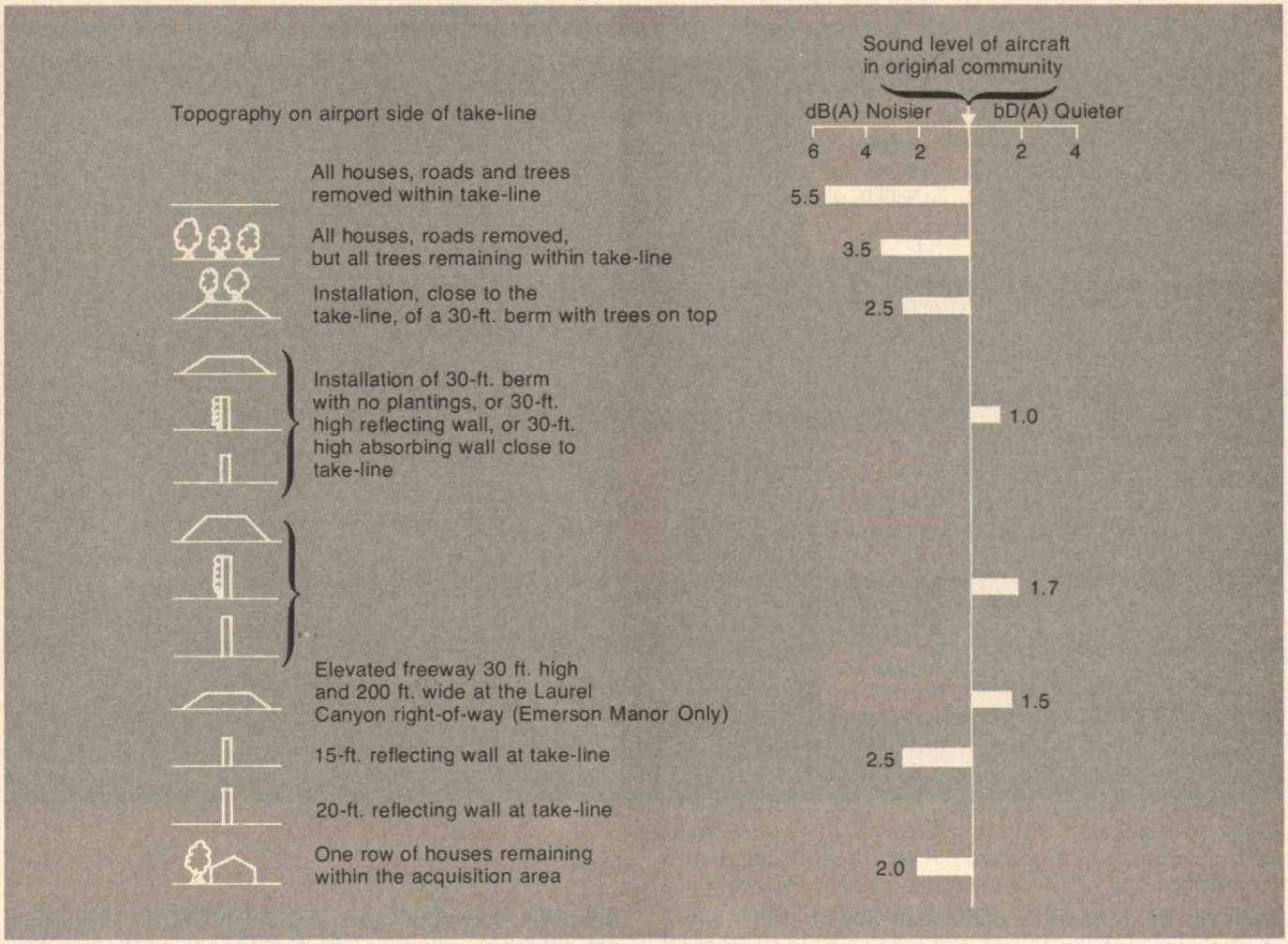
— what trees do to sound; are they a noise barrier or do they provide a pathway for noise into otherwise quiet areas? (The answer is that they do both depending on their use.)

Several students at M.I.T. have now provided substantial, if not complete, answers to these questions, largely by applying modeling techniques.

While we were studying these basic questions, we received an unusual opportunity to apply scale modeling to an important practical problem. The director of Los Angeles International Airport asked us to study the effects of noise barriers around a runway extension at the airport. Runway 24-R at L.A. International had been upgraded and its usage increased, which increased the noise in the neighboring communities due to the aircraft during take-off roll, and thrust reversal after landing. As a remedy, the airport boundary was extended into the community and the houses within that boundary were being bought up and removed. The houses at the new edge of the community would be exposed to noise levels somewhat lower than were the edge houses before. But the people in those houses were new "edgers," and would find their noise levels increased. The airport director wanted to know whether a noise barrier at the airport boundary could replace the noise insulation supplied by the houses that were removed. A scale model study seemed to be the ideal answer since any full-scale experimental barrier study would be very expensive.

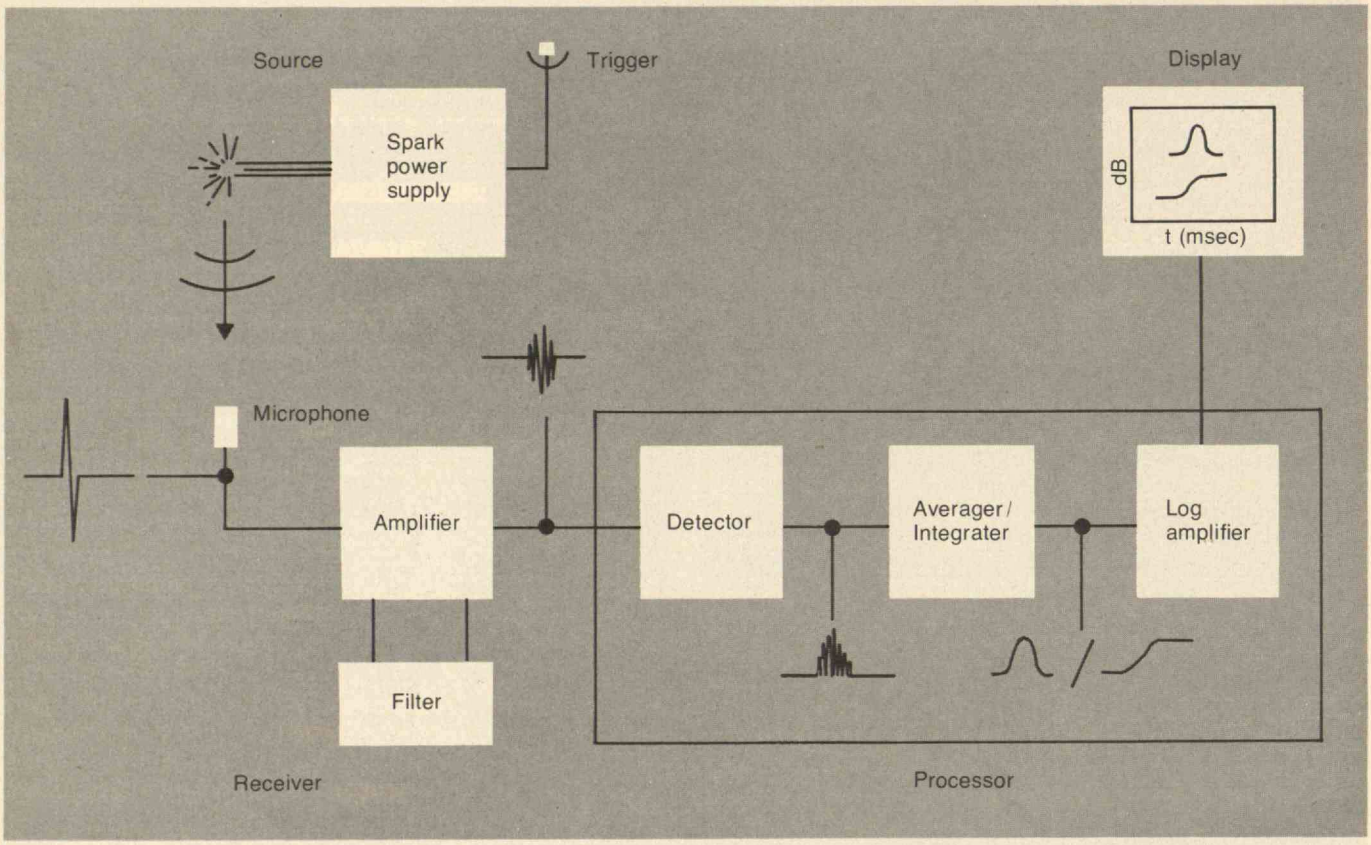
A campus patrolman shoots off a pistol in an M.I.T. courtyard to measure noise propagation for comparison with model data.

We studied two sections of runway and adjoining community — Emerson Place, a relatively flat area, and Westchester, a fairly hilly region. Four thousand feet of runway and a total distance of 2,000 feet from the runway into the community were constructed in model form at a 1:80 scale (*see p. 60*). The houses were simulated using painted styrofoam, the trees were made of nails and Easter basket grass, and the ground from a combination of porous fiberboard and flocked paper. Streets and sidewalks were laid out using plastic sheet. The model was built on a wooden framework that matched the required topographical form of the area. We estimate that the topographical contours on ths model conformed to maps of the area within ± 2 ft., and the houses, trees, sidewalks, etc. were placed within a similar accuracy.



The attenuation of sound by barriers at an airport take-off line. Results of the author's studies of Los Angeles Airport.

Since the model was so large, we expected considerable attenuation of sound due to geometric spreading, air absorption and blockage by the model itself. Thus, we needed a high-energy sound source to study how noise spread throughout the model. (We measured the sound at various points by recording from tiny microphones stuck up into the model from beneath.) We chose an electrical spark as our source, and being an impulsive sound, it provided other benefits as well. The times that various sound pulses took to arrive at the microphones in the model could be recorded and obviously spurious pulses that bounced off a nearby wall or lamp fixture could be ignored or eliminated by placing sound absorbing material. Normally, one can adjust air absorption of sound by varying the humidity. At a scale of 1:80, however, the absorption of sound at full scale by the air cannot be simulated in the model by changing the humidity. But by using an impulsive signal, we could adjust the gain of the microphone amplifier to amplify the later arriving pulses to compensate for the extra air absorption. This adjust-



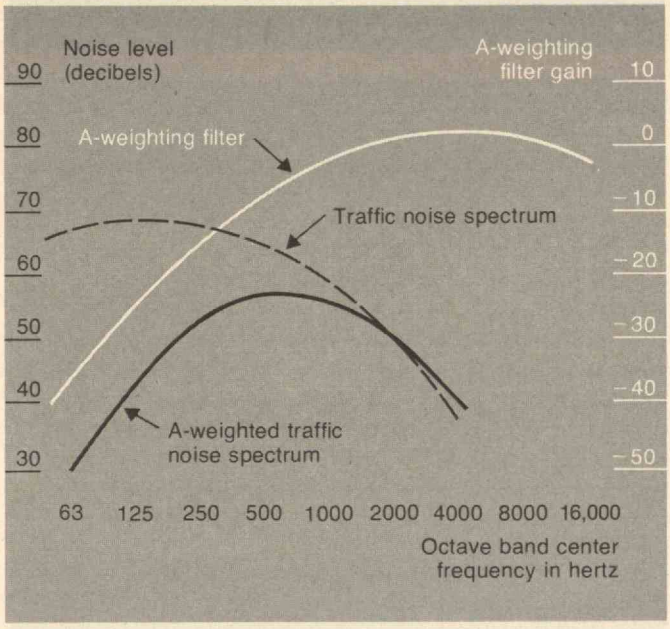
ment can be done either mathematically or electrically.

The results of our tests are shown on page 63. It turns out that any airport boundary barrier greater than 20 ft. high of nearly any construction should attenuate the sound enough. The only exception is the tree-covered earth berm, which appears to be poorer because sound is scattered by the trees over the top of the barrier into its shadow. Undoubtedly, a very thick grove of trees surrounding a barrier can increase its effectiveness but sparsely planted trees intended as a visual screen appear to be deleterious to barrier performance. Highway builders and industrialists should take note of these findings when constructing sound barriers around their projects.

Designing Quiet Projects

Architects and engineers frequently construct scale models of projects to determine the appearance of a design, sightlines, access, layout and so forth. During the airport project, I began to wonder whether acoustical evaluation could be included in the architectural modeling procedure. This would mean developing a hardware system (sound source, microphone, process and display) simple and reliable enough to be used by architects and engineers. Our experience with the research studies and the L.A. airport model suggested the feasibility of such a hardware system, and with support from the National Science Foundation's R.A.N.N. Program (Research Applied to National Needs), we began developing a prototype system.

It was obvious that some method of checking sound levels in a proposed project was needed. The typical project is to be constructed on a site with noise makers surrounding, and perhaps within the project. Buildings already on the site may be removed, final project layout is



The diagram at the left shows the acoustical modeling system developed for the National Science Foundation, to be used by architects and engineers in designing building projects for lowest noise levels. The filter performs so-called "A-weighting," giving more emphasis to more noisome higher frequencies. The results of this filtering on urban noise is shown in the graph above.

undecided, and traffic patterns may be changed when the project is complete. There is, therefore, no reasonable set of field measurements on the present configuration that could possibly anticipate the impact of noise makers on the project when completed.

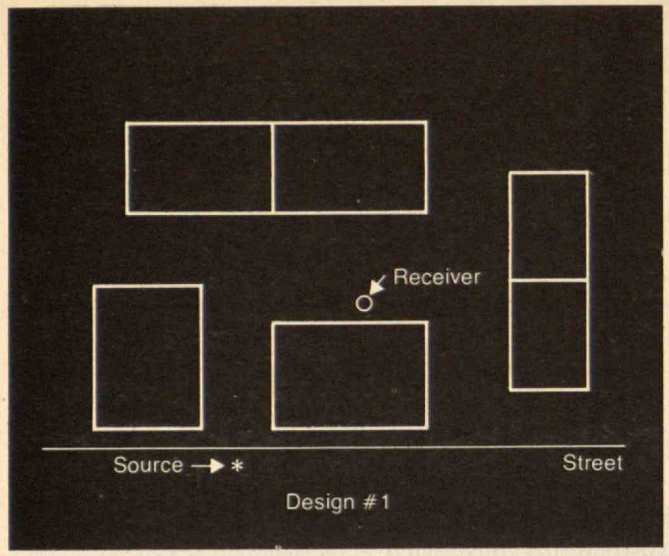
Noise produced by the project during construction and after completion (if it is a transportation facility, for example) is a problem, as is the impact of that noise on the surrounding community. Computing noise levels may be sufficient in some instances, but very often the geometry of the situation is too complicated to yield to calculation. Acoustical models help measure the noise propagation from exterior noise sources into the site and from the site into the community. Changes in site layout and topography can be quickly made and their effects on noise levels measured.

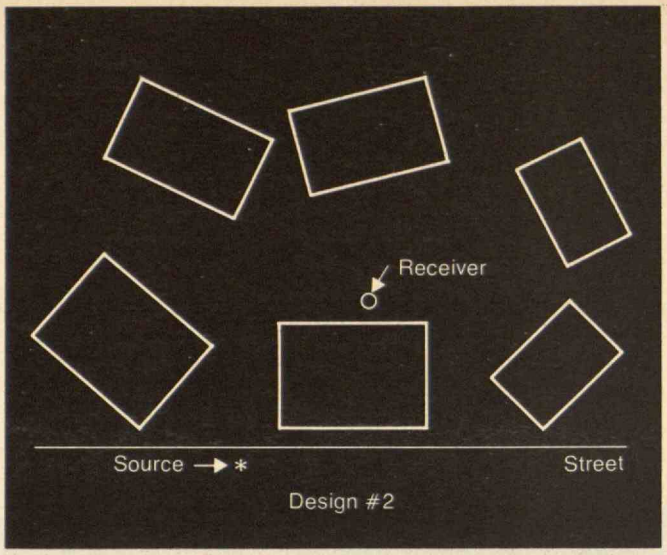
There are difficulties, however, in applying acoustical techniques to architectural models. Models of projects are customarily constructed at a scale of 1:100 to 1:300. Such small scaling-ratio causes difficulties in acoustical modeling since the sound frequency used for data analysis must be raised in inverse ratio to the geometric scaling. In a 1:50 model, for example, the noise frequency of 1,000 Hertz (Hz) when scaled down becomes 50,000 Hz. In a 1:200 model, we must be able to take data at 200,000 Hz. air absorption of this sound, the small microphone size required and the difficulty of obtaining good frequency response make such frequencies impractical. So, acoustical scale models must be larger than the models that planners and architects customarily work with.

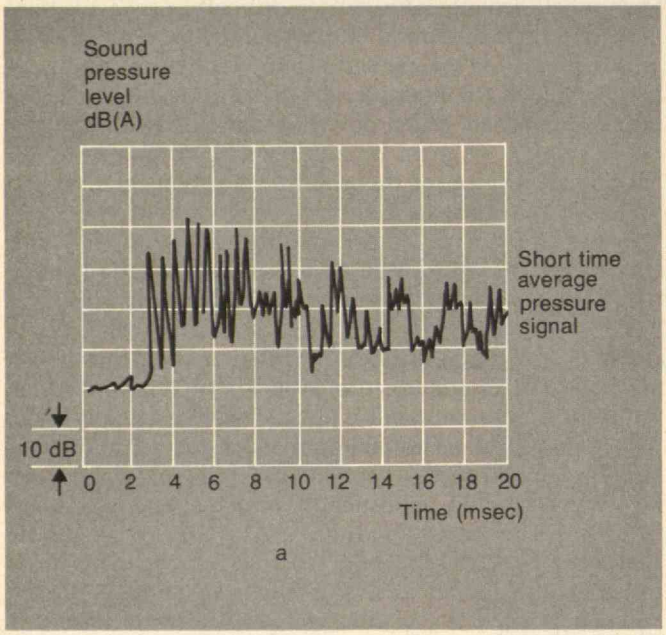
The material from which the acoustical model is constructed will probably also be different than those normally used in an architectural model. Visual impression is not important acoustically, but in most cases the model will probably do additional duty as a visual planning aid. Highly detailed representations of building features are not necessary for acoustical purposes. The scattering from such features as windows and façade texture can be simulated by attaching thin strips of cardboard or plywood to the model facing. Trees may or may not be necessary, but it is the safer course to put them in. The ground should be constructed from a board that simulates the impedance of the earth, and the topography of the area must be built into the model.

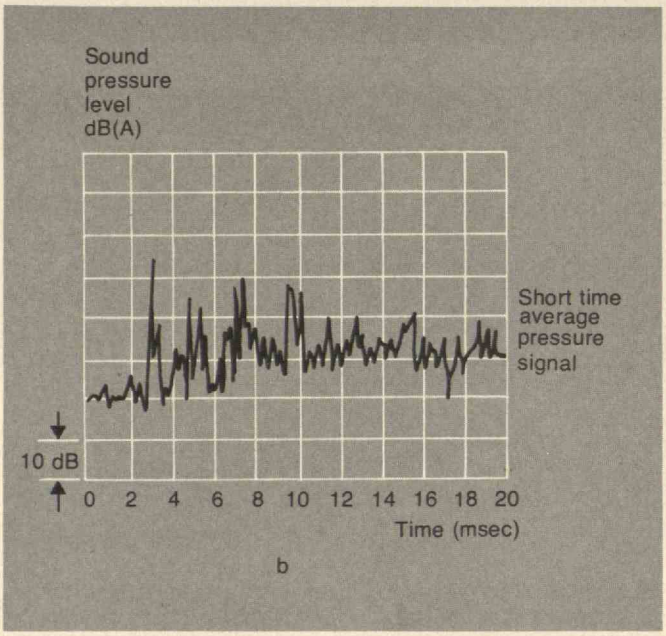
On page 64 is the acoustical modeling system developed for the R.A.N.N. study. It consists of a triggered spark source of controlled energy that emits a sharp sound pulse about 50 microseconds in duration. This sound wave, which contains a very broad spectrum of frequencies, propagates through the model and is received by a small crystal microphone and amplified. It is then passed through a filter which "scales up" the sound spectrum to make it correspond to real life. In many cases, the measurement would be the "A-weighted" reading of a sound level meter measuring traffic noise. A-weighting is a process of giving a greater weight to higher sound frequencies, to better reflect the nuisance factor of a noise: higher frequencies cause more disturbance to humans than do lower frequencies.

The received, filtered and amplified signal is fed into the processor/display system which first rectifies it and then performs either a short time average or total integration of the signal. Averaging smooths the signal so that the time variations in the sound intensity are retained, and so that the individual sound pulses can be distinguished as they arrive at the microphone.

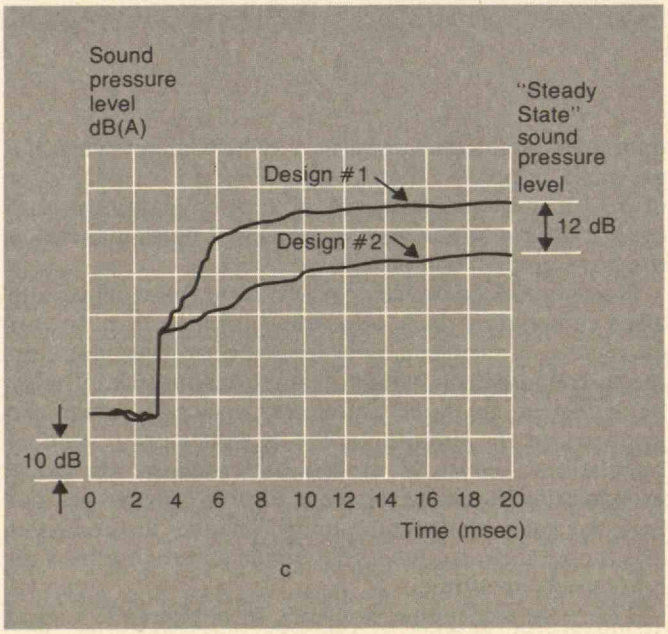








Using modeling to decide a building project layout. With a spark noise source placed along the street, and the receiver within the courtyard, it is possible to measure which layout will be quieter. In the sound data from the first layout, note in the corresponding graph the first diffracted pulse and the numerous subsequent pulses caused by reflection from the buildings. The strength of these subsequent pulses is reduced in the second layout. An integration of the signals from both layouts (third graph) confirms that the second layout is 12 decibels quieter than the first.



Integration adds the signal energy for the various paths and gives the architect or engineer a simulation of steady-state noise.

On page 66 is a simplified example of how the system is used in site planning of a project. One layout is a "squared-off" arrangement of buildings around an open courtyard and the other a more random arrangement. Suppose that a busy street runs alongside this complex and we are concerned about noise penetration into the courtyard. The spark source is placed along the street in the model and the signal received in the courtyard as shown. As you can see from the sound data on page 66, the second design clearly produces a quieter courtyard than the first for this source-receiver combination. Of course, one would move the spark source and the microphone to several locations on the street and in the courtyard to make sure that the benefit was not confined to a very small region.

To test how well our acoustical modeling system corresponds to real life, we have made two full-scale field experiments on the M.I.T. campus — in the two large courtyards, Killian Court and McDermott Court. In both cases, an impulsive sound source was located on a nearby street at a sequence of locations and the resulting sound was recorded at a number of locations in these courtyards. We then constructed models at a scale of 1:50 and made measurements at locations corresponding to source and receiver placements at full scale (*see page 62*). A starter's pistol was used as a sound source in the Killian Court experiment and a yachting cannon was the source in the McDermott Court experiment. From our results, it was apparent that the model can give quite good predictions of the expected sound level.

As part of the N.S.F.-funded program to develop a modeling system useful to planners and engineers, three user organizations have been selected to try the system in practical noise evaluation problems. These groups are the New York City Environment Protection Administration, the Massachusetts Department of Transportation, and Justin Gray Associates of Cambridge, Mass. We have also instructed students, educators, agency personnel and industrial personnel in modeling techniques in workshops at M.I.T.

Besides its practical uses modeling has also proved to be a very useful educational tool, enabling demonstration of many fundamental propagation phenomena in quantitative terms. Among these phenomena are geometric divergence, air absorption, and reduction of sound upon reflection, the diffraction of sound by various shapes of barriers and the scattering of sound by trees. Consequently, phenomena usually treated in a rather theoretical and abstract manner can be made very real to the student by classroom demonstrations.

Modeling can provide accurate answers to noise problems; answers that would be very difficult to obtain any other way. We've found that models can be built in a matter of man-hours with enough accuracy for acoustical purposes and attractive enough for architectural purposes. Educators, agency personnel, and engineers from industry can learn to use the system quickly, get good data, and have fun doing it! I am optimistic that acoustical scale modeling has an excellent future as a tool in evaluating noise problems in the workplace as well as in the research laboratory.

Suggested Readings

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DeJong, Richard and Stusnick, Eric, "Scale-Model Studies of the Effects of Wind on Acoustic Barrier Performance," *Proceedings of Inter-Noise '74,* Washington, D.C., September 30-October 2, 1974.

Delaney, M. E.; Rennie, A. J.; and Collins, K. M., "Scale Model Investigations of Traffic Noise Propagation." NPL Acoustic Report No. Ac58, September, 1972.

Donovan, P. R., "Model Study of the Propagation of Sound from V/STOL Aircraft into Urban Environs." M.Sc. Thesis, M.I.T., Dept. of Mech. Eng., DOT-TSC-93, Dept. of Transportation, September, 1973.

Kinney, W. A., and Pierce, A. D., "Helicopter Noise Experiments in an Urban Environment." DOT-TSC-93, Dept. of Transportation Interim Report, January, 1973.

Lyon, R. H., *Lectures in Transportation Noise,* Grozier Publishing, 1973, pp. 110-132.

Lyon, Richard H. and DeJong, Richard, "Acoustical Modeling System for Site Evaluation," *Journal of the Acoustical Society of America*, Vol. 58, No. 2, August, 1975.

Masiak, J. E., "Model Studies of Acoustic Barriers." M.Sc. Thesis, M.I.T., Dept. of Mech. Eng., August, 1973.

Spandock, F., "Die Vorausbestimung der Akustik eines Raumes mit Hilfe von Modelversuchen." Report of 5th ICA Meeting, Liege 1965, Vol. 2, p. 313.

Winkler, H., "Die Entwickling eines Senders und Empfangers fur Raumakustische Modellmessungen mittles Echogrammen." *Hochfrequenztechnik und Electroakustik,* Vol. 73, (1964) pp. 132-138.

Richard H. Lyon is Professor of Mechanical Engineering at M.I.T., specializing in acoustics and vibrations. He received his Ph.D. in physics at M.I.T. in 1955 and has taught at the University of Minnesota and was on the staff at Bolt Beranek and Newman Inc. He is a founder of Cambridge Collaborative, Inc., an acoustics research and development firm.

Frictionless Trains and Palindromes

Puzzle Corner
by
Allan J. Gottlieb

As many readers noticed, there were no Kings on the board of our chess problem in December (**DEC 1**); somehow they were printed as Queens. So change them back to Kings, try again, and I will print the solution in the July/August issue.

Problems

M/A 1 We begin this month's selection with a bridge problem from Russell A. Nahigian: South is declarer at a contract of six spades. How can he make the contract after West leads ♥K?

	♠K Q 3 ♥ – ♦ Q 8 3 ♣ A K 9 8 6 4 2	
♠ J 10 8 ♥ A K 6 4 ♦ K J 7 4 ♣ 7 3		♠ 6 ♥ 9 8 7 5 3 2 ♦ 10 9 2 ♣ Q
	♠ A 9 7 5 4 2 ♥ Q J 10 ♦ A 6 5 ♣ 5	

M/A 2 John Prussing wants you to recall the Fibbonacci numbers defined by: $F_1 = F_2 = 1$ and $F_{n+2} = F_n + F_{n+1}$ for $n \geq 1$. This sequence begins 1,1,2,3,5,8,. . . . The problem is to prove that

$$\lim_{n\to\infty} \frac{F_{n+1}}{F_n} = \frac{1+\sqrt{5}}{2}$$

M/A 3 Jack Parsons has a problem derived from Lewis Carroll: A frictionless train runs by gravity in a *straight* tunnel between two points on the earth's surface. Find the maximum velocity and the time for a round trip. Show that the latter is independent of the length of the tunnel.

M/A 4 The following entertaining problem is from Dr. Ben Whang: A palindrome is, of course, a word or a sentence which spells the same thing when spelled backwards. Among the notable are:

Raddar
Rotator
Madam, I'm Adam.
Able was I ere I saw Elba.
Lewd did I live & evil I did dwel'.
A man, a plan, a canal — PANAMA.

Extending the concept, Dr. Whang became curious about the word to describe a word (or a sentence) which spelled another word (or a sentence) when spelled backwards. For example,
deer, stop
devil, sung,
reviled, repaid,
reward, etc. (There are hundreds more.)

After doing a bit of research at the Library of Congress, and running into words like apocope, epenthesis, and metathesis, Dr. Whang found that the word he is looking for does not exist. Therefore, he has decided to coin it! The word is "drow." Its preferred pronunciation rhymes with "brow." A palindrome then would be a special case of a drow. The beauty of "drow" is that it is a drow itself, while the word palindrome is not a palindrome. The longest drow Dr. Whang knows has eight letters. He wants *Review* readers to find the word. And, he writes, "I wish my last name was Wang, which of course is a drow."

M/A 5 This problem, from Bill Saidell, is reminiscent of **Perm 1:** Construct the integers from 1 to 30 using four 4s. For example $4 = \sqrt{4} + 4 + 4 + 4$. Note that the "greatest integer function" is not allowed.

Speed Department

M/A SD1 A timely problem from Eric Jamin:
Z.P.G.? It is well known that all families want a son. The method to satisfy people and limit population growth is thus obvious: You may have children until you have a son, but then you must stop having children! What will the reproduction rate of the population be? How will its male-female ratio, starting at one, evolve? (Assume monogamy, a maximum of marriages with no remarriage, immortality for married people before a son is obtained, no twin births, no other limits on family size than the one stated.)

M/A SD2 While "flying from N.O. to N.Y." Joseph Horton wondered how far away the horizon was, for a given altitude. Presumably Mr. Horton was in an airplane at the time.

Solutions

DEC 1 As mentioned in the introduction, the Kings were misprinted as Queens. Solutions will appear in the July/August issue.

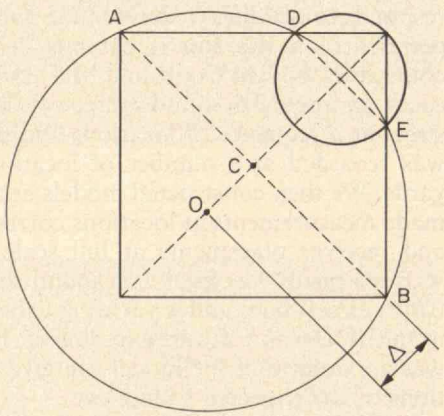
DEC 2 What is the minimum total area of two circles which cover a unit square? Three circles? Four circles?

Most people felt that the best one can do is to use one circumscribing circle and the rest null circles (radius zero). If null circles are technically excluded, most proposed small circles (radius 1/N, N large). Thus the minimum area would be

$$\tfrac{1}{2}\pi + (K-1)\pi/N^2 \approx \tfrac{1}{2}\pi$$

where K = 2,3,4 is the required number of circles.

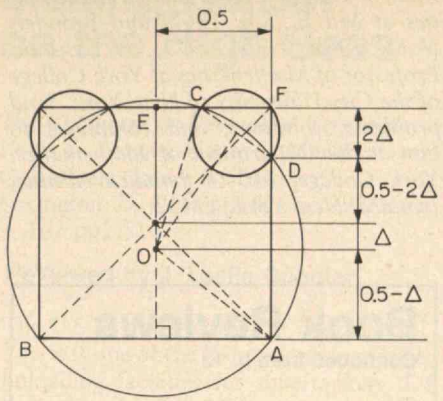
Harry Zaremba, however, achieves a smaller area for K = 3. His solution follows:



In the two-circle case, the large circle is drawn through A and B with its center at O, a distance Δ from the geometric center C of the square. The small circle is drawn with its radius equal to one half of the intercepted chord DE. If Δ is decreased, the area of the small circle can be made as small as it is desired to imagine. Since AB $= \sqrt{2}$, the limit of the area of the two circles will be the following minimum:

$$A = \pi/4(\sqrt{2})^2 = \pi/2 = 1.570796.$$

In the three-circle case, the large circle is drawn through A and B with its center O a distance Δ below the center of the square. The centers of the two small circles are at



the midpoints of the chords intercepted between the sides of the square. From the figure, the radius

$$OA = OC = [(0.5)^2 + (0.5 - \Delta)^2]^{\frac{1}{2}}$$

$$EC = (OC^2 - OE^2)^{\frac{1}{2}} = [(0.5)^2 - (0.5 - \Delta)^2 - (0.5 + \Delta)^2]^{\frac{1}{2}} = (0.25 - 2\Delta)^{\frac{1}{2}}$$

$$CF = EF - EC = 0.5 - (0.25 - 2\Delta)^{\frac{1}{2}}$$

$$CD = (CF^2 - FD^2)^{\frac{1}{2}} = \{[0.5 - (0.25 - 2\Delta)^{\frac{1}{2}}]^2 + (2\Delta)^2\}^{\frac{1}{2}}.$$

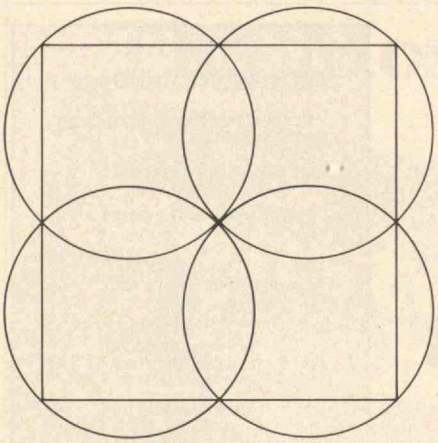
The area of the circles,

$$A = \pi[OA^2 + 2(CD/2)^2] = \pi[0.75 - 2\Delta + 3\Delta^2 - 0.5(0.25 - 2\Delta)^{\frac{1}{2}}].$$

Setting the derivative of A with respect to Δ to zero, and simplifying:

$$288\Delta^3 - 228\Delta^2 + 56\Delta - 3 = 0.$$

Solving for Δ gives $\Delta = 0.07355$. Substituting in the expression for A yields the minimum area $A = 1.44117$.



In the four-circle case, the radius of each circle $R = \frac{1}{2}\sqrt{2}/2$. The total minimum area of the circles

$$A = 4\pi(\sqrt{2}/4)^2 = \pi/2; \quad A = 1.570796.$$

The result is the same for two and eight circles.

Also solved by Neil Cohen, R. Robinson Rowe, Winslow H. Hartford, Ralph Menikoff, Abe Schwartz, Joseph Horton, William J. Butler, Jr., Gerald Blum, A. Stephen Tepper, and Richard I. Hess.

DEC 3 A problem concerning words containing sequences of letters in alphabetical order: What is the fewest number of words needed so that the consecutive strings use all 26 letters?

I did not accept the names of organic chemicals; given this exclusion, the minimal solutions used five words; the following list is from Richard I. Hess:

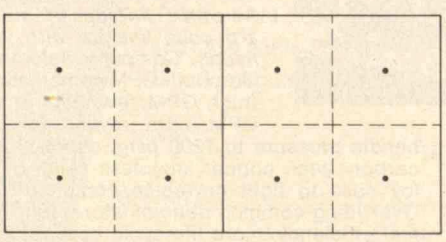
Bright-faced	(A to I)
Lumberjack	(J to M)
Propinquities	(P to U)
Vow	(V, W)
Oxygenize	(X to Z)

Also solved by Gerald Blum, William J. Butler, Jr., Abe Schwartz, Ralph Wanger, Winslow H. Hartford, S. J. Warner and Virginia S. Glessner, R. Robinson Rowe, Harvey Elentuck, William F. Nornick, George H. Ropes, Avi Ornstein, Dave Rabinowitz, Hugh W. Thompson, Emmet J. Duffy, Harry Zaremba, and the proposer, Don Forman.

DEC 4 Take two unit squares and place them side by side so that they form a rectangle two units wide and one unit high. Now choose a point A at random in the first square and, again at random, a point B in the second square. Then A and B will be a certain distance apart. Question: If we repeat the random choice of A and B many times, how far apart will they be on the average?

Before presenting a solution, let me clarify the origin of this problem by reprinting a letter I received from Art Schact: "I was a little startled to see my name in "Puzzle Corner" as having submitted the problem. Association of my name with this problem stems presumably from the news release I prepared about it, a copy of which is enclosed. The placing of my name in the upper right corner, no doubt the cause of the confusion, was intended simply to provide editors with a point of contact. You will see from the text of the release that the problem was actually proposed by Charles R. Johnson and solved by Hans J. Oser, both of National Bureau of Standards. Perhaps you could give credit to these gentlemen in the March/April issue, when you plan to publish the answers."

Several readers gave approximate answers obtained by drawing a grid on each square, connecting the center of each subsquare of square A to the center of each subsquare of square B, and averaging the lengths. For example, an order two grid is



Note that one has 2^2 dots to connect to 2^2 dots giving 2^4 lines. William J. Butler, Jr., carried this out to order 12 ($12^4 = 20{,}736$ lines!) and obtained the approximation 1.08750. This took ten *hours* on an HP55 calculator. Dr. Oser solved the problem by integrating

$$\int_0^1\int_{-1}^0\int_{-\frac{1}{2}}^{\frac{1}{2}}\int_{-\frac{1}{2}}^{\frac{1}{2}}[(x1 - x2)^2 + (y1 - y2)^2]^{\frac{1}{2}}\,dx1\,dx2\,dy1\,dy2.$$

His solution appears in *SIAM Review*. Several readers set up the above quadruple integral but none solved it analytically. Steve Hirshman and John E. Prussing used probability theory to solve the problem. Dr. Prussing's answer is

$$29/30 - \sqrt{2}/15 - \{4\log[(\sqrt{3} - 1)/2]\}/3 + \{\log[(1 + \sqrt{3})/(3 - \sqrt{3})]\}/6 + \log[(\sqrt{2} - 1)/(\sqrt{2} + 1)] - \sqrt{3},$$

which has the decimal approximation 1.08813825. The solution is obtained as follows: Let the cartesian coordinates of the two points be (x1,y1) and (x2,y2) where x1, y1, and y2 are in [0,1] and x2 is in [1,2]. The distance function d is then $[(x2 - x1)^2 + (y2 - y1)^2]^{1/2}$.

Define $a = y2 - y1$ and $b = x2 - x1$. Then a is in [−1,1] and b is in [0,2]. The distance function d is then $(a^2 + b^2)^{\frac{1}{2}}$. The probability density functions for a and b can be calculated using the Convolution Theorem and the fact that the xk and yk are uniformly distributed random variables. The result is that the density function for a, f(a), is

$$f(a) = \begin{cases} 1 + a & -1 \le a \le 0 \\ 1 - a & 0 \le a \le 1 \end{cases}$$

Similarly for b we get

$$f(b) = \begin{cases} b & 0 \le b \le 1 \\ 2 - b & 1 \le b \le 2 \end{cases}$$

Since a and b are independent, the joint density function is $f(a,b) = f(a)f(b)$.

The expected value of d is obtained by integration of the product of d with the joint density f(a,b) over the appropriate domain:

$$\begin{aligned} E(d) &= \int_0^2 db \int_{-1}^1 da\, \sqrt{a^2 + b^2}\, f(a,b) \\ &= \int_0^1 db \int_{-1}^0 da\, \sqrt{a^2 + b^2}\,(1 + a)b + \\ &\quad \int_0^1 db \int_0^1 da\, \sqrt{a^2 + b^2}\,(1 - a)b + \\ &\quad \int_1^2 db \int_{-1}^0 da\, \sqrt{a^2 + b^2}\,(1 + a)(2 - b) + \\ &\quad \int_1^2 db \int_0^1 da\, \sqrt{a^2 + b^2}\,(1 - a)(2 - b) \end{aligned}$$

Note that the first two integrals are equal and the last two integrals are equal. These integrals can be evaluated analytically by transforming to polar coordinates: $a = r \cdot \cos t$; $b = r \cdot \sin t$. The evaluation is straightforward (but tedious) and results in the answer given at the beginning of the solution.

Also solved by R. Robinson Rowe, Winslow H. Hartford, Harry Zaremba, Neil Cohen, Ralph Wanger, Ralph Menikoff, Joseph Horton, Neil Hopkins, Norman Wickerstrand, and Richard I. Hess.

DEC 5 Show that there is an infinity of trigonometric functions of real numbers that are algebraic numbers. Specifically, given any real number a, where cos a is an algebraic number; if T is any direct trigonometric function, show that T(ma/n) is an algebraic number for all integers m and n.

This amazing result is actually rather easy. The key is that sin(nx) is a polynomial in sin(x) since sin(a + b) = sin(a)cos(b) + cos(a)sin(b). (If n is negative use sin(x) = −sin(−x)). R. Robinson Rowe supplies a polished answer:

We note first that if any trigonometric function of an angle is an algebraic number, so are all the others. Let a be a tabulated angle; then any other tabulated angle can be represented by Na/D, where N/D is a proper rational fraction. Also let S = sin a and C = cos a. Then using the addition formulae for sine and cosine, we have:

$$\sin 2a = 2SC, \qquad \sin 3a = 3S - 4S^3,$$
$$\sin 4a = 4SC(1 - 2S^2), \qquad \sin 5a = 5S - 20S^3 + 16S^5$$

and so on. Thus sin Na is always an algebraic number. If N is odd, it is expressed in powers of S alone; if N is even, it is expressed as C times powers of S. But if we square an N-even expression and substitute $1 - S^2$ for C^2, we have an expression in powers of S alone. For example, this procedure yields

$$\sin^2 4a = 16S^2(1 - S^2)(1 - 2S^2)^2$$
$$= 16S^2 - 80S^4 + 128S^6 - 64S^8$$

Now, generally, consider the character of sin Na/D = sin x = X. Depending upon the parity of N, we have either:

$$\sin Dx = \sin Na = AX + BX^3 + CX^5 + \ldots JX^N$$
$$\text{or } \sin^2 Dx = \sin^2 Na = AX^2 + BX^4 + CX^6 + \ldots JX^{2N},$$

where A, B, C, etc. are positive or negative integers. In either case we have an algebraic equation in X and its roots will be algebraic numbers.

Also solved by: William J. Butler, Jr., Richard I. Hess, Winslow H. Hartford, Philip O. Martel, Neil Cohen, and the proposer, Eugene W. Sard.

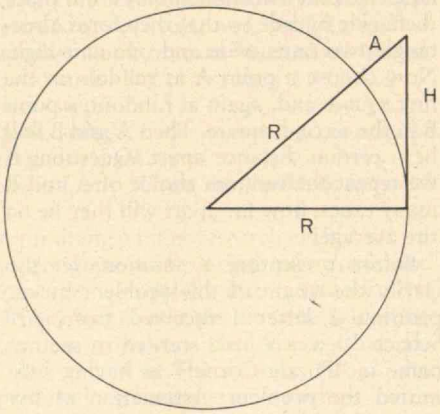
Proposer's Solutions to Speed Problems

M/A SD1 The answer is shorter than the question! Each family has one son; since boys and girls are born with equal probability, each family has *an average* one daughter. Hence: reproduction rate: 1 for 1 (Z.P.G.!!!). Male-female ratio: constant at 1.

M/A SD2

R = Radius of earth

$H = (2AR + A^2)^{\frac{1}{2}}$



Allan J. Gottlieb, who studied mathematics at M.I.T. (S.B. 1967) and Brandeis (A.M. 1968, Ph.D. 1973), is Assistant Professor of Mathematics at York College of the City University of New York. Send problems, solutions, and comments to him at the Department of Mathematics, York College, 150-14 Jamaica Avenue, Jamaica, New York, 11432.

Book Reviews

Continued from p. 13

temporal order of variables is clear. For example, a city's socio-economic conditions precede a mayor's adoption of an urban renewal plan; i.e., "city" is prior to "agenda." Over longer periods, it is true, a more dynamic relationship may be seen, and here the systems perspective is useful. But surely no one, including mayors, can avoid making causal inferences about the world, and these are better made explicit.

Arnold M. Howitt, former Fellow at the Joint Center for Urban Studies, is Assistant Professor of Political Science at Brown University.

Making Harbor on the High Seas

The Challenge of Deepwater Terminals
Louis K. Bragan, Henry S. Marcus, Gary C. Raffaele, James R. Townley
Lexington: D. C. Heath & Co., 1975; xxi + 162 pp., $14

Reviewed by J. Leslie Goodier

The U.S. is a major user of imported oil. Yet, it is one of the last nations to provide unloading facilities for supertankers. Of the approximately 50 deepwater ports in operation or under construction, 15 are in Europe, 10 in Japan, and 5 in Canada. Now deep port projects for the U.S. are imminent.

The U.S. Department of Transportation's Office of Deepwater Ports anticipates that at least five deepwater ports will be built in the U.S. The present trend in offshore port construction requires tankers to couple to single-buoy moorings in the open seas, in some cases farther than 30 miles offshore. From the mooring, the crude oil is unloaded and pumped ashore to an oil treatment and storage facility. At least one offshore platform is positioned between the tanker and the coastline. The platform provides booster power to the ship's pumping system which transfers the oil from ship to shore.

The present trend in offshore port construction is to couple tankers to single-buoy moorings miles offshore. Crude oil is unloaded at the mooring and pumped inland for treatment and storage. (Photo: J. Ray McDermott & Co., Inc.)

No Pint-Can Competition

Applications to the U.S. Coast Guard are pending for the installation of single-buoy mooring facilities off the coasts of Louisiana and Texas.

According to U.S.C.G. Captain K. G. Winan, oil transported by supertankers of 200,000- to 400,000-ton capacity will save between 40 and 60 per cent in shipping costs. Lower shipping costs would mean cheaper crude and cheaper refined products — "billions of dollars cheaper," says Captain Winan. "It is impossible to compete with the world when we buy oil in pint cans while others order by the truckload. There are not enough pint-sized ships available nor do we have the terminal capacity to handle them."

Existing U.S. ports are limited by rock outcroppings, which generally restrict navigational channels to depths of 36 to 40 ft. Yet the Dutch advocate a minimum 15 per cent draft between keel and sea floor. Thus it is cost beneficial to set moorings in deeper water rather than attempt extensive dredging and rock removal.

Our nation's slow involvement in deepwater port development has been beneficial to some extent. Attempts to deepen existing ports by dredging have, in most cases, wrought environmental catastrophe by changing wave patterns, diverting the natural flow of littoral currents, causing saltwater encroachment into riverine areas, and accelerating upriver erosion. Hence, as a nation, we are about

to see single-buoy mooring, deepwater ports that may permit us to reclaim some of our valuable coastline for recreation rather than heavy industry.

A Narrow Environmental Perspective

The Challenge of Deepwater Terminals tells the story of deep port development, presenting detailed statistics in a fashion geared to readers having prior knowledge of the topic. The authors slough over conventional piers, sea islands, and sea island piers in favor of single- or multi-buoy moorings, even though island installations have proven a most satisfactory means of unloading and, in some cases, transferring oil.

But whatever mooring is used, experience indicates that, when in port, a 300,000-ton tanker costs $60 per minute to operate. So for this reason alone, every effort will be made to moor the vessels for as short a time as possible, once U.S. development is underway.

Offshore terminals may warrant a sizeable increase in the labor force: approximately 40 to 50 workers will be needed to man the offshore platform alone. And some rivalry is predicted among organized labor groups.

Our environmental perspective is unavoidably narrow as a result of limited historic operational data and information on spills experienced by foreign deep ports. Clearly, an assessment of foreign port operations would help us to develop environmental management criteria for U.S. installations. But in any event, the supertankers will be fully laden when entering U.S. waters. And they will dispose of oil-contaminated ballast water on the high seas until such discharges are internationally prohibited.

The authors stress that the U.S. is *not* prepared to deal with a catastrophic spill from a supertanker. The deepwater ports should, however, reduce traffic at inner harbor locations and eliminate the present practice of tankers with only a minimum of bottom clearance creeping in with the tide.

In the short term, we need deepwater port facilities because we need foreign oil supplies. But changes in world consumption may occur. Already some refineries are limiting production and still meeting demand. At some locations, 200,000-ton tankers are standing idle in a semi-mothballed status, and orders are being cancelled for new supertankers. In addition, production techniques have substantially increased recovery of crude oil from terrestrial reservoirs, and thus many "depleted" oil wells in the U.S. are pumping once again.

J. Leslie Goodier is a Senior Staff Engineer of Arthur D. Little, Inc. He has surveyed operational deepwater ports in Europe for the U.S. Army Corps of Engineers, and has assessed the impact of such installations in New Jersey, Texas, Louisiana, and South Carolina.

A Nostalgic Perspective

M.I.T. In Perspective
Francis E. Wylie
Boston: Little, Brown, 1976, xii + 220 pp., $15.00

Reviewed by John I. Mattill

The Model T on the roof of East Campus is an M.I.T. legend — one of many now preserved in print in "M.I.T. in Perspective," by Francis E. Wylie. Can readers identify the two students waving to an enthusiastic audience below? (Photo: M.I.T. Historical Collections)

We live amidst a renaissance of nostalgia, when many find relaxation and joy in recalling ways of the past — the Victorians, the flappers, Dixieland, foxtrots, Duesenbergs, Glenn Miller, Pop art, and Op art. An auspicious time to launch a pictorial history of M.I.T. which will prompt in every reader associated with the Institute a nostalgic recall: Rogers and Runkle . . . pitot tubes . . . electron microscopes . . . Whirlwind . . . differential analyzer . . . "a place for men to work and not for boys to play" . . . football and field day . . . Bosworth, Churchill, Hunsaker, Swallow, Lewis, Jackson, Walker, Compton, Bush, Van de Graaff, Wiener, Killian, Draper, Schmitt, Samuelson, Keenan, Stratton, Luria . . .

Something from everyone's memories is here, in a book which is at once surprisingly small and surprisingly rich, even to the publication of a number of photographs unfamiliar to an editor who has had an intensive engagement with pictures of M.I.T. for 25 years. Clearly, Mr. Wylie's 15 years as Director of Public Relations at the Institute left him with a vivid understanding of M.I.T. and its history, his 11 years in *Time/Life*'s Boston bureau with uncommon skills in the use of words and pictures

Right and Timely Vision

M.I.T.'s place in American education is secure; the Institute is rated now, as Mr. Wylie notes, among the best institutions in the country in engineering, architecture, management, and several of the sciences and social sciences. It was not always so; William Barton Rogers' vision of a school that would "overtop the universities of the land" by making scientific principles a basis for industrial progress must have seemed an audacious vision indeed (Mr. Wylie's phrase) in 1861. Even 50 years later a parochial "Boston Tech" was surely arrogant to claim such an expanse of classic sandstone on the banks of the Charles, and pompous to mount such an elaborate allegorical pageant to convey its seal and charter from Boston to Cambridge.

No reader of Mr. Wylie's book can fail to speculate: how is it that so much of what the Institute has touched has turned to gold; that this institution, among scores of American universities rising from equally modest beginnings, has come to be in the first rank?

Seek no single answer in Mr. Wylie's book, or in any other, for it is a question that must puzzle better historians than those who have yet recorded their judgments.

The roster of the Institute's early alumni makes it clear that the founder's vision was both right and timely: the du Ponts, Sloan, Cabot, Little, Whitney, Coolidge, Stone, Douglas, Doolittle, Webster, Swope . . . It cannot have been by accident that so many M.I.T. men became founders and leaders so quickly in so many American enterprises based in technology.

Their success in turn assured the further success of the institution from which they came. The result was a combination of quality and quantity for its faculty in every field of M.I.T.'s principal focus. There are many examples of that strength in *M.I.T. in Perspective* and more in every professional journal of engineering, science, architecture, and management. For example, the late Joseph S. Newell, '19, wrote his book on *Airplane Structures* just as he joined the faculty in 1929; "it is impossible to exaggerate the impact of this book on the education of aeronautical engineers," wrote *Astronautics and Aeronautics* last fall.

William Barton Rogers' emphasis on the useful applications of scientific knowledge has not been lost on his successors. From the student's perspective, the Institute faculty may occasionally seem so preoccupied with consulting and research that they do too little educating. But that is a short-sighted view. Few engineering institutions have been by explicit policy so positive and generous as M.I.T. in encouraging faculty participation in industry and government, and the harvest of achievement for the Institute and its graduates has been a very rich one.

Past as Prologue to a Different Future

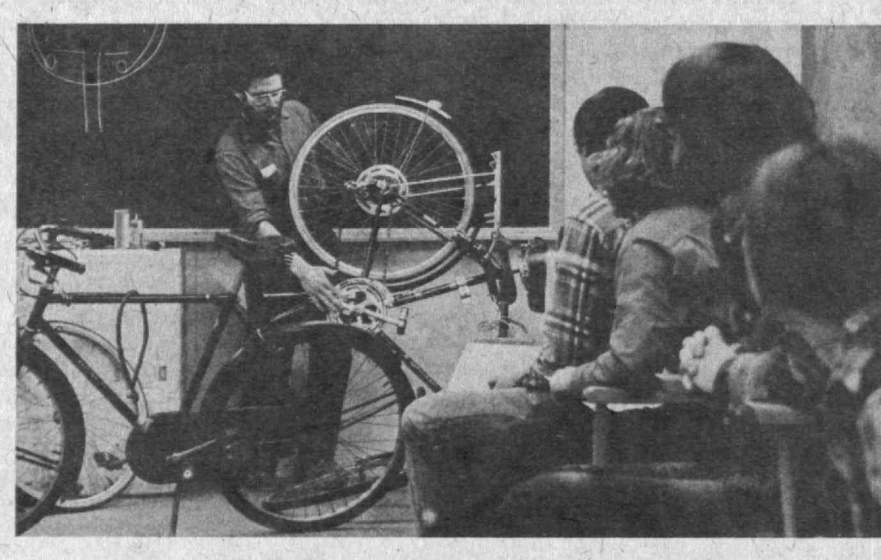
Much of the engineering pioneered at M.I.T. and so ably chronicled in *M.I.T. in Perspective* has been reduced to practice. But unfilled needs remain, and there are still frontiers on which scientists and engineers are at work. These frontiers lie further into sophisticated science than ever before; hence the growing specialization and ever-deeper penetration of engineers into theory and research. The recent achievement of the Bitter National Magnet Laboratory's Alcator experiment is wholly consistent with any pioneering work in M.I.T.'s past.

But science, engineering, architecture, management, and the social sciences now must take wholly new directions, too. It is this issue which M.I.T.'s present leadership addresses in an essay on "Managing a Complex Society," written in support of the new Leadership Campaign:

"As we enter the last quarter of a century whose central feature has been the rapid advance of science and its application, our greatest challenge is to understand and manage our successes within the framework of a vigorous and constantly evolving free enterprise system. The advances have increased our quality of life and our freedom of choice, but they have also increased the size and complexity of society and thus compounded a formidable array of technological and social problems. This is the central dilemma of our times."

Can the past be prologue to this very different future? Mr. Wylie's book attempts no answer, but it supports a conclusion which must be shared by all who know the Institute: no educational institution in the U.S. is better positioned to deal with broad new issues in which technology and the social sciences must interact.

John I. Mattill came to M.I.T. in 1948; since 1966 he has served as Editor of Technology Review.



Daily life at M.I.T. takes on a very different style in January: it's Independent Activities Period —a time for doing what there isn't time to do in a term filled with lectures, quizzes, and problem sets. Here are five among over 430 activities from which to choose: (top) design a small house for a client; (center) learn to make music on a saw; (above) record the M.I.T. Chamber Players for the new campus cable television (see page 77); (top, right) try metal sculpture; and (right) learn how to repair your bicycle. For a complete I.A.P. report, see pages 82 to 87. (Photos: Calvin Campbell and Mark H. James, '78)

Institute Review

In This Section

More Applicants, More Early Decisions for Class of 1980; Admissions Summarized

More than 600 high school students applied to enter M.I.T. in September, 1976, before the December deadline for "early actions," and 286 of these were admitted as the calendar year ended. They have until May 1 to tell the Institute whether or not they will come.

Those numbers are about double those of the year before, and the students admitted at this stage are "certainly among the finest in our applicant pool," says W. Thad Byrd, '74, Assistant to the Director of the M.I.T. Educational Council.

The jump in the number of "early action" applicants resulted from a procedural change, thinks Peter H. Richardson, '48, Director of Admissions: scores on College Board achievement tests taken in both July and November could be considered for "early action" this year.

In two respects the students applying for "early action" late in 1975 pleased Mr. Richardson: the number of women tripled; and the number of minorities requesting early action showed "a significant increase."

Picking 1,100 Students from 4,900 Applicants

Meanwhile, the Academic Council has directed Mr. Richardson to seek a class of 1,100 to enter in September, 1976. That's larger than classes of the first four years of the decade, says Paul E. Gray, '54, Chancellor, because budget problems "dictate that we either increase enrollment and make better use of our facilities or cut faculty and staff." The former is the chosen course, with a 10-per-cent increase in undergraduates in prospect between 1974 and 1978.

Total applications for the Class of 1980 which will enter M.I.T. in the fall are higher than ever before — including 14 per cent more women than last year. "You can only speculate at this stage of the game, but I'd have to say that something's happening in the kids' heads to make them more job-oriented, more interested in practical studies," Mr. Richardson told Michael D. McNamee, '76, of *The Tech*.

The process of reviewing 4,900 final applications is now proceeding. The goal, says Mr. Richardson, is "a class of individuals with a diversity of talents"; but this doesn't necessarily mean a class composed chiefly of well-rounded or truly versatile individuals.

"Rather, it means a group of academically able students, each of whom has some real contribution to make to their classmates' education and to the general life of the community. We do not ask the individual to conform to someone's preconceived notion of versatility, balance, or roundness," says Mr. Richardson, "but we do hope that each one will have some attributes, well enough developed, to make him or her interesting — even exciting."

A Matrix of Scholastic and Personal

A three-stage process begins as soon as each applicant's file — final application form, high school transcript, interview report, College Board test scores, and letters of recommendation — is complete:

— One member of the Admissions Office staff and one member of the faculty read each student's file to rank applicants' general personal qualifications and reach, for each student, a Personal Rating (PR). There is "no check list of desirable qualities or activities," says Mr. Richardson, but qualities like creativity, inquisitiveness, personal force or energy, leadership, and enthusiasm are listed as important. "It is the quality of participation in which we are interested, rather than the quantity," he says. "It is the intensity of the commitment, rather than the number and types of commitments, which we consider significant."

— Statistical procedures are used to integrate data from high school records and College Board tests into a Scholastic Index (SI) for each applicant. The goal is to "help us identify those students who are most likely to be successful, academically, at M.I.T.;

each of the components which, in the past, has demonstrated itself to be a reliable predictor is used in combination with the others."

— With PRs and SIs established, applicants are put on a matrix — the best PRs at the top, and the best SIs at the left. At this stage the entire applicant group is reviewed again, and finally the "selection process attempts to find the most qualified through an intercomparison among the applicants."

All this takes place, "as a matter of policy," says Mr. Richardson, "without any specific awareness of the applicants' financial circumstances." Independent evaluations are made after admission by the Student Financial Aid Office of the family's financial strength, and a package of loan, job, and scholarship grant is put together to meet those costs which are beyond the contribution which the student and his/her family seem able to make.

Ready for the Freshman Year?

Materials from two groups of applicants have special attention, says Mr. Richardson:

— Applications from minority candidates — blacks, Spanish-Americans, and American Indians — are reviewed "with a particular sensitivity to the educational environment from whence they come." To some extent this is not an exception; it is, in fact, "our approach to all applicants," says Mr. Richardson, "all must be ready for the challenges of the freshman year."

— A final review is given to applications from sons, daughters, and grandchildren of M.I.T. alumni. "The standards are the same," says Mr. Richardson, the intent of this special review being "to be certain that the application is carefully considered." □

More than a preview of next year's squeeze in the dormitories: 106 people in a Baker House "coffin single" in this year's annual Baker House Coffin Stuffing.
(Photo: T. Klimowicz, '77)

Continuing Effort to Reach Minorities

How can M.I.T. attract more applicants from among America's minorities — blacks, Spanish-Americans, and American Indians?

The answer to that question is the new assignment of John L. Mack, '73, who began work as Assistant Director of Admissions on January 1.

Mr. Mack's qualifications are impressive: before beginning his professional career at the Institute, Mr. Mack was a member of the first "Interphase Project," the pre-freshman summer session that introduces students from disadvantaged educational backgrounds to M.I.T.'s first year of academic study. During his undergraduate years, while majoring in urban studies and planning, Mr. Mack was Co-Chairman of the Black Student Union and a member of the M.I.T. Task Force on Educational Opportunity.

But the present leadership of the M.I.T. Black Student Union was unimpressed. Its Admissions and Political Action Committees had asked that "an experienced black person with at least five years' admissions experience at a prestigious white institution" should replace John A. Mims, who left the post of Assistant Director of Admissions last fall. The demand was part of a larger protest against what the B.S.U. said was a decreasing effort on the part of the Institute to identify and admit black applicants.

Paul E. Gray, '54, Chancellor of the Institute, responded with a statement that the Institute "is fully committed to the recruiting of minority students," and he insisted that there has been no diminution of M.I.T.'s effort. Indeed, he said, some 5

J. L. Mack

per cent of all minority students in the U.S. whose College Board scores indicate that they might be successful here do in fact apply at M.I.T. The equivalent fraction is only about 2 per cent among minority students.

"All of us at M.I.T. share with our black students the desire that there be even more minority students enrolled at the Institute than there are now. . . . Our present plans are to intensify [our] effort, and we expect to be even more successful in minority recruitment in the future than we have in the past."

Mr. Mack completed a year of graduate study in system dynamics in the Sloan School of Management before joining M.I.T.'s Personnel Office in staff recruitment in 1974. He has been active in the Cambridge Community Center, of which he was President for four years, the M.I.T. Urban Action Committee, and Hope for Housing in Newburyport, Mass.; and he is a founder of the Dearborn Project, a tutoring program for students in Roxbury, Mass.

Tuition Up $300; Will Meals Tax Hurt More?

Tuition will rise $300 — to $4,000 for the academic year (two terms) — effective at the beginning of the 1976 Summer Session. That's an increase of 8.1 per cent.

It is a necessary response to the increasing cost of salaries, wages, and educational materials, says Paul E. Gray, '54, Chancellor: "We are helpless in the face of continuing inflation."

The new increase means that by September, 1976, tuition will have doubled in a decade. The figure was $1,900 in 1967; a total of $1,500 has been added since 1970. But in constant 1967 dollars, M.I.T. tuition grew only 2 per cent a year between 1967 and 1973, and in constant dollars it has been unchanged since then. "The increase in nominal dollars has just held us even with inflation" since 1972-73, says Dr. Gray.

President Jerome B. Wiesner told a student press conference when the tuition increase was announced that "a real effort" had been made to hold the rate of increase below last year's, when the figure went up by $350. He stressed M.I.T.'s concern to keep the growth rate of tuition below that of median U.S. family income.

And Chancellor Gray noted that the new $4,000 tuition represents approximately the same proportion of the average starting salary of an M.I.T. graduate as did tuition in the 1950s and 1960s.

Keeping M.I.T. Competitive

Will a $4,000 tuition fee affect M.I.T.'s ability to attract outstanding students for the Class of 1980, entering next September? Michael McNamee, '76, Editor-in-Chief of *The Tech,* asked Jack H. Frailey, '44, Director of Student Financial Aid. Probably not, thinks Mr. Frailey, because most other institutions with which M.I.T. competes for students are mak-

ing similar — or slightly larger — tuition increases.

But Mr. Frailey has a different concern: the impact on student budgets of an 8-per-cent Massachusetts meal tax which will become applicable to college and university dining halls and fraternity dining rooms in September, 1976. That adds perhaps $100 to the budgets of most students attending Massachusetts colleges and universities, and "it makes Massachusetts colleges look $100 worse than schools in other states," Mr. Frailey told *The Tech.*

Even as Mr. Frailey spoke to *The Tech,* three bills were being introduced into the Massachusetts legislature to provide relief from the meals tax for college students; and Carola Eisenberg, Dean for Student Affairs, was urging M.I.T. alumni and parents to support these efforts to eliminate "this tax on a basic necessity — a student's meals in his or her home away from home." □

Phones, Water Up

An 8-per-cent tuition increase was forecast by Paul E. Gray, '54, Chancellor of M.I.T., in his budget report to the faculty last fall (*see January, pp. 73-74*). In that report, Dr. Gray forecast a deficit of $3.4 million for 1975-76, to be reduced to about $2 million in 1976-77 by stabilizing salaries, cutting some marginal programs, increasing slightly the number of undergraduate and graduate students, increasing the flow of gifts, and increasing tuition.

Since then, inflation has continued to take its toll.

Higher telephone rates have been reflected in M.I.T. telephone bills; a 15-per-cent rate hike granted late in 1975 may add $500,000 to a $2.3 million budget item. Local calls cost about $26,000 a month, more than $400 per year per employee, says Morton Berlan, Superintendent of Communications.

M.I.T. payments to the City of Cambridge for water service will rise $150,000 in 1976. The Institute used over 85 million cubic feet of water in 1975, says Thomas E. Shepherd, Jr., '50, Superintendent of Utilities, and the price is going up 18 cents per hundred cubic feet.

In November, 1975, M.I.T. paid $12.85 per barrel for industrial oil — about the same as a year earlier. But the price of electricity was up to 3.49 cents per kilowatt-hour, from 3 cents in 1974.

Cable-TV Premieres at M.I.T.: Toward a New Way of Learning and Teaching

Can technology applied to the process of education improve teaching and give students and faculty new opportunities to learn and a new sense of community?

To that rhetorical question Ithiel de Sola Pool, Professor of Political Science, gives a conditional affirmative. His experiment has now begun: a two-mile cable television loop extending from the West Campus to the Hermann Building began carrying programs of all kinds in January. Television sets displayed the programs in M.I.T. corridors, and television sets in offices and East Campus dormitories could be connected to receive pictures and sound for modest cost.

"Do those new opportunities for learning mean an 8 a.m. physics lecture recorded a day ahead for students who are still in bed?" quipped President Jerome B. Wiesner during a faculty meeting at which Professor Pool was introducing the cable-TV concept.

Professor Pool was unperturbed. The cable-TV committee, he said, urges the simplest guidelines for those who would participate by putting programs on the "tube": the principal function must be education, not entertainment; and anyone in the community who thinks his use of the cable will fit that requirement ought to have access.

Two channels are now available: Channel 8, the principal medium for "official" cable-TV programming, and Channel 10, reserved for productions managed, produced, or recommended by students operating as M.I.T. Student Cablevision.

The Worst Thing: To Be Ignored

A wide variety — as promised — of programming found its way onto Channel 8 during the first month of operation during the Independent Activities Period: lectures in courses prepared by the Center for Advanced Engineering Study, including such topics as colloids, stochastic estimation, and surface chemistry . . . a credit course entitled "Introduction to Experimentation" . . . "M.I.T. — the Institution," a seminar on the history and organization of the Institute taped during the 1974 I.A.P. . . . "Engineering in the 1970s," a seminar taped when given for alumni in 1972 . . . WGBH programming from the "Nova" series and even from the "Science Reporter" series of the late 1960s . . . a series of special interviews . . .

Professor Pool warned the faculty as the cable was going on the air that its programs would be experimental — "successes and failures," he said. At least for the first months, it would be as important for the user to have the experience of participating — to see what works and what is the response — as for the viewer to watch.

"I hope it will be controversial," said Professor Pool. "The worst thing would be if nobody cares."

Putting together a television show is a new experience opened for M.I.T. students by the advent of campus-wide cable television. The process begins with a color camera (above); then comes an "electronic darkroom" where video tapes are viewed, edited, and mixed. (Photo: Mark H. James, '78)

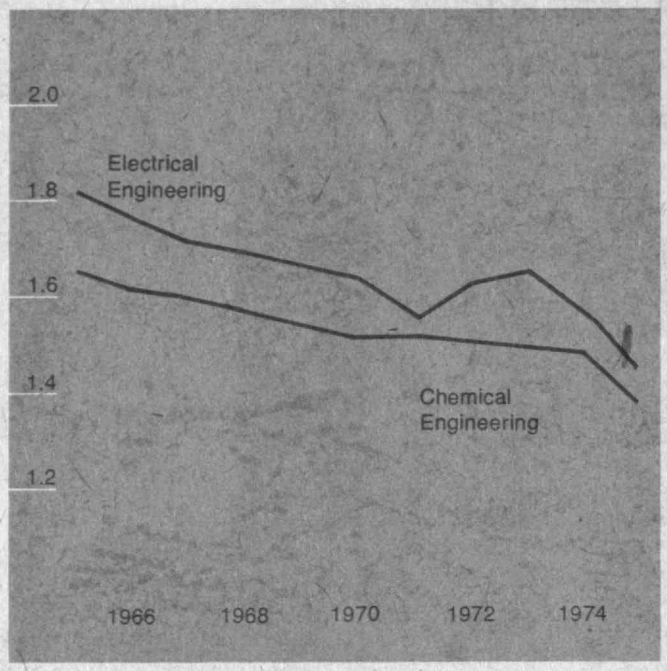
A Tool Like the Telephone

The Center for Advanced Engineering Study is "custodian" of the cable television system, operating it within the scope of activities already in place for making self-study films. Professor Pool, Professor Wilbur B. Davenport, Jr., Sc.D. '50, Head of the Department of Electrical Engineering and Computer Science; and Professor Myron Tribus, Director of C.A.E.S., were members of the original planning committee.

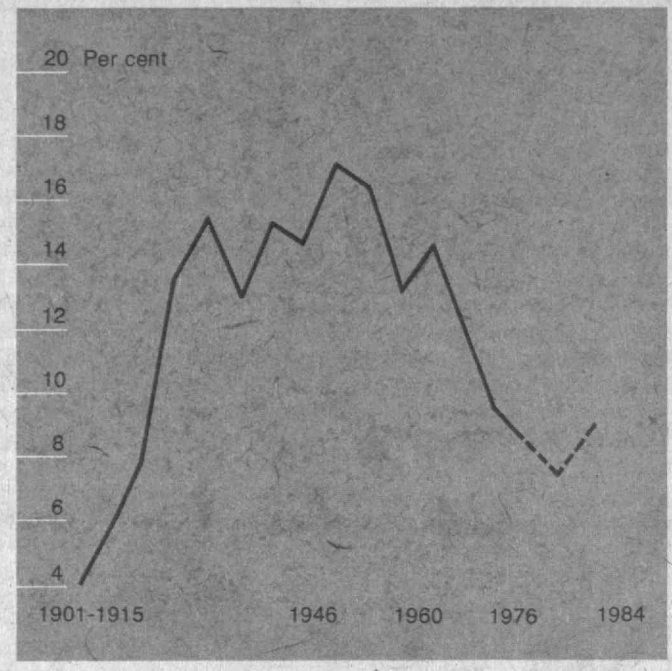
A $620,000 grant of the Alfred P. Sloan Foundation made possible installation of cables and the equipment now in use. A proposal for an additional $500,000 has been made to cover equipment and seed money for cable-TV projects, and Professor Pool told the faculty he expects the activity to grow as people propose programs, add equipment, and make connections into the system.

Niti Salloway, Program Manager for C.A.E.S., says she hopes the campus will come to think of the cable as we think of the telephone — "a quick and constantly available tool for extending themselves and getting closer to other parts of the M.I.T. community." She hopes all cable users will share "in the artistry and freshness afforded by an experimental system such as ours." □

1975: "Sluggish Market," But a Good Year To Have a New M.I.T. Diploma



The declining value of a doctorate. The chart shows the differential in average starting salaries of doctorates and bachelors in engineering going into industry from M.I.T. since 1965.



Engineering has had a declining role in U.S. undergraduate education since World War II. Even in 1915 engineering schools claimed a larger proportion of all U.S. undergraduate students than in 1975. An irrational aversion on the part of young people to the technology on which we increasingly depend?

Despite recession, 1975 was a good year for M.I.T. students entering the job market. Salaries were highest — and jobs most plentiful — for engineers (especially chemical engineers), geologists, and graduates of the Sloan School of Management, but only architects and planners continued to face a "bleak" job market.

More firms sent recruiters to M.I.T. in 1975 than in any year since 1969-70, and salary offers in general kept pace with the rising cost of living.

As the economy continues to strengthen, says Robert K. Weatherall, Director of Career Planning and Placement in his 1975 annual report, indications are strong that 1976 will be "a still better year" for M.I.T. students entering the job market.

These predictions for 1976 are based on the number of corporate recruiters scheduling visits to M.I.T. this spring and on national predictions that while the number of science and engineering degrees given in the U.S. will rise slightly in 1976, demand will also grow — especially in fields connected with energy (including geology), agriculture, management, and finance.

A "Sluggish Market" for Technical Talent

M.I.T. seems to have been ahead of the nation as a whole in 1975.

John D. Alden, '49, Executive Secretary of the Engineering Manpower Commission of Engineers Joint Council, says there was a sudden drop in engineering recruiting nationwide, making 1975 the poorest year for engineering employment since 1972, when aerospace-industry cutbacks were taking their toll. Between 1974 and 1975 there was a 25 per cent drop in the number of offers made to new bachelor's graduates in engineering. That fact seems "particularly depressing," says Mr. Alden, because engineering graduates were fewer in 1975 than in 1974 — down 8 per cent.

Deutsch, Shea, and Evans, Inc., a New York-based consulting firm which specializes in technical placement advertising and professional manpower research, says the whole of 1975 offered "a below-average, sluggish market for technical talent."

Average Salaries: $875 to $1,663

Of M.I.T.'s 859 S.B. graduates in 1975, Mr. Weatherall reports, 68 per cent (up from 66 per cent in 1974) went on to graduate school. Ninety-two seniors entered medical school, at least 25 went to law school, and 20 were admitted to business schools.

Of the rest, 92 — 13 per cent of the class — took jobs in industry, at salaries ranging from $875 to $1,540 per month. The mean salary of S.B. engineering graduates was $1,120 and of science graduates, $1,054. (The national averages of starting salaries for bachelor's graduates in engineering in 1975 were $1,109 (men) and $1,144 (women) according to the College Placement Council; in science the national average was $940.)

The averages of salaries offered to new master's degree holders entering industry from M.I.T. in 1975 were $1,271 in engineering, $1,608 in management, and $1,242 in science.

Salaries offered to doctorates in 1975 represented less of a premium over bachelors' salaries than in previous years, continuing a trend which has prevailed for at least a decade. But the demand for the reduced number of technical Sc.D.s and Ph.D.s who received degrees in 1975 (294, down from 348 in 1971) was at least as good as in previous years. Academic opportunities were down, and more doctorates, particularly from the School of Science, took jobs in industry. Average salary offers were $1,663 for engineering graduates, $1,519 for science graduates.

Though doctorates from the School of Humanities and Social Sciences faced what Mr. Weatherall calls "severe competition" for jobs, 60 per cent found teaching jobs in universities and colleges; Ph.D.s in economics especially were in demand. Indeed, among Institute departments, economics and civil engineering contributed most new Ph.D.s to the academic profession in 1975, writes Mr. Weatherall.

The Declining Appeal of Engineering

What of the future?

Surveying potential employers late last fall, the College Placement Council in December reported that firms oriented to engineering and business would increase their hiring by 2 per cent in 1976. But a hiring drop of up to 19 per cent was possible in a

category called "sciences, mathematics, and other technical."

There will be perhaps 2,000 more bachelor's graduates in engineering in 1976 than in 1975, an increase of close to 5 per cent, according to Mr. Alden.

But there are hints of increasing demands in the future. Speaking in Texas last fall, Robert C. Seamans, Jr., Sc.D. '51, Director of Energy Research and Development Administration, said the need for scientists and engineers in energy-related industries will climb from 141,000 in 1970 to 230,000 by 1980 and 308,000 by 1985. He cited estimates by the National Planning Association: new jobs by 1985 in federal research and development programs for 12,000 physicists, 14,000 chemists, 6,000 mathematicians, 40,000 electrical engineers, 18,000 chemical engineers, and 22,000 mechanical engineers.

Meanwhile, Engineering Manpower Commission estimates show the number of engineering degrees trending slowly up-

The Declining Value Of College Going

Measured in terms of the cost of tuition compared with the immediate and even ultimate salary advantages it promises, the value of a college education is plummeting.

In financial terms only, the rate of return on a college investment may now be as low as 7 per cent — an "unprecedented" drop from 11 to 12 per cent in five years since 1969, write Richard Freeman and J. Herbert Hollomon, '40, in a paper from M.I.T.'s Center for Policy Alternatives.

In 1966 a college graduate's salary might be 25 per cent above that of a high school graduate in the jobs each was likely to find after receiving their differing diplomas; now the average differential is as little as 10 per cent.

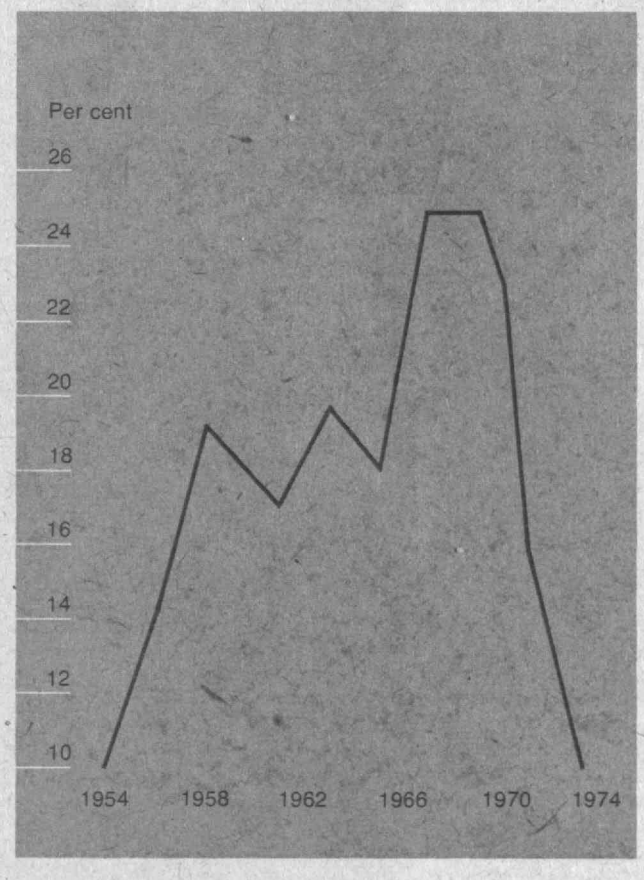
In the same way, the financial advantage of a master's degree has been eroded in the decade just ending; only a business school graduate can now expect a substantial financial reward for his investment in graduate study.

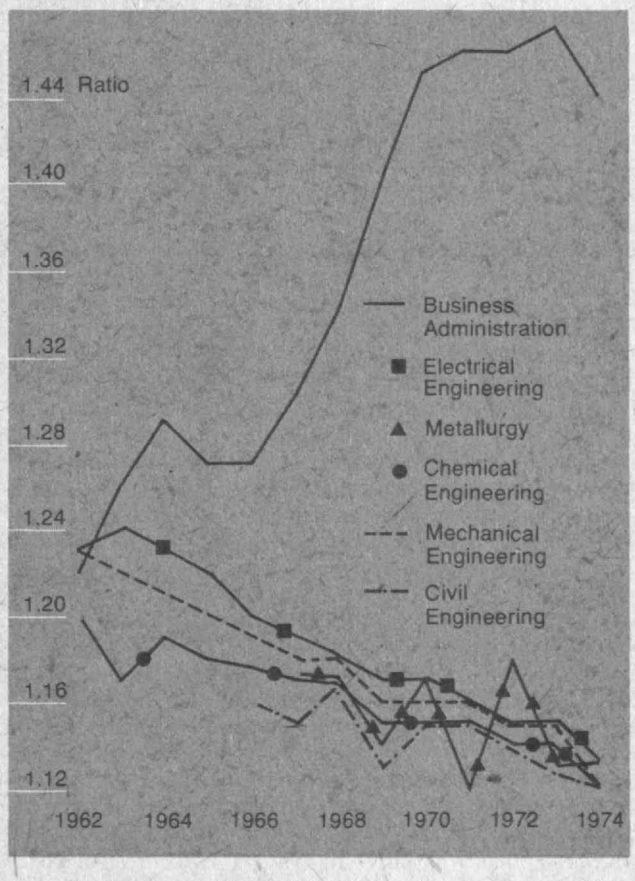
All this, write Professors Freeman and Hollomon in *Change* magazine *(September, 1975, pp. 24-31)*, is part of a general erosion of the market for college-trained people which is the basic reason why "the golden age of higher education" is over.

The "Freeman-Center for Policy Alternatives 'Recursive Adjustment' Model" of the college job market suggests that the situation will begin to change by early in the 1980s. That's because college attendance will go down for the rest of this decade — a response to the poor job market and low salaries that await college graduates. By the 1980s there will once more be a shortage of people qualified for special jobs requiring college-taught skills.

Meanwhile, it will be an era of hard times for universities and their faculties — and perhaps for their students as well, think Professors Freeman and Hollomon. (Dr. Freeman is Professor of Economics at Harvard, Dr. Hollomon Director of the Center for Policy Alternatives and Professor of Engineering at M.I.T.) □

If you graduated from college with a bachelor's degree in 1966, you could expect your first job to pay 25 per cent more than you could have earned upon graduation from high school four years earlier (left chart); now that differential is down to less than 10 per cent. In the same way, the financial reward for a master's degree — the differential in starting salaries for engineers with and without master's degrees (right chart) — has slipped continuously (with the exception of students in management) since 1962. Thus the rate of return on a college education is dropping sharply, say Professors Richard Freeman and J. Herbert Hollomon, '40, and college enrollments are falling as young people perceive that college-going is not the bonanza it was a decade ago.





ward from 1976 through 1982, when the total of bachelor's degrees may be as high as 54,000. But at best this will represent a very modest inroad by engineering into undergraduate education; the proportion of bachelor's degrees given in engineering has been declining steadily since the 1950's in the U.S. and most other major industrialized nations, and for Mr. Weatherall that raises a "significant question": to what extent is this trend in harmony with the changing needs of an advanced society, and to what extent does it reflect an aversion to the technology on which we increasingly depend? □

Management: Dealing With "Multi-lemmas"

What is the essential difference between management and the other professions?

Many professionals can define their obligations in bilateral terms — the professional and his client. A doctor, for instance, can work to eradicate disease in his patient without worrying about the effect on society as a whole.

But managers confront "multi-lemmas," says William F. Pounds, Dean of the Sloan School of Management. Their judgments must involve the interests of employees, stockholders, and public, for example. Such multifaceted judgments "are what managers are for," Dean Pounds told members of the Alumni Advisory Council last winter, and preparing students to make them is part of the task of a school of management.

How does the Sloan School prepare students to deal with such "multi-lemmas"? Four main stems in the educational program:

— Economics and finance, domains "of great practical importance to operating managers," said Dean Pounds. All Sloan School students study economics in "substantial detail." From the Sloan School's faculty in the field of fiscal and monetary policy has recently come what Dean Pounds calls a "research revolution" which has "substantially changed our perception of how the capital markets work."

— Organizational studies, the relations of people and of organizations.

— Management science, really "the technology of management," said Dean Pounds, concentrating on analytical methods and their application. The M.I.T. environment of strength in computer science, mathematics, economics, and the social sciences molds the Sloan School's approach here.

— Topics in management policy — multinational corporations, legal issues, system dynamics, corporate strategy, innovation and patent policy.

Every Sloan School student — whether working for a bachelor's degree or studying management for ten weeks as a senior executive — works in all four of these areas, says Dean Pounds, because as managers all will confront the same problems. Undergraduates tend to be impatient with ambiguity, he told the alumni, and they thrive on abstract analysis both quantitative and behavioral. Senior executive students are at the other end of the spectrum: they are most turned on by ethical and policy issues.

Only one out of eight to ten students who apply to the Sloan School can be admitted, says Dean Pounds, and he likes it that way: management education, he told the alumni, "is a highly competitive market in which talented students are a great source of ideas and energy, the strongest resource we are able to recruit."

If the demand is so great, asked one alumnus, why not increase the size of the programs? Because at present prices we could not generate funds necessary to finance the resources these students would require. Why not raise the price? We have proposed that several times.

But finances are a perennial problem, Dean Pounds admitted, and he is concerned that the private sector no longer matches the public sector in supporting management research. Dean Pounds fears this imbalance will result in an imbalance in educational programs — "a bias in our expertise, perhaps even in our interests and tastes." □

The Sloan School Is Now Number Three

The nation's business school deans, asked to rate graduate business programs on the basis of academic quality, have moved M.I.T.'s Sloan School of Management up to third place, after Stanford and Chicago.

The annual survey, conducted by *MBA* magazine, also asked the deans to rank the employment value of an institution's master's degree in management.

The deans placed Stanford first, Chicago second, Sloan School third, Harvard fourth and Carnegie fifth in the academic quality ranking. Harvard and Stanford were tied for first in the employment value rating by the deans, Wharton was third, Sloan fourth and Chicago fifth.

". . . The most decisive move was that of the Sloan School," said the article in the December issue of *MBA* which reported the survey results and compared them to a survey a year ago.

"It was one of only two schools — U.C.L.A. was the other — to move up in the rankings of both survey groups and on both questions.

"Among deans, Sloan had ranked fifth on both questions last year; this year it ranked fourth for employment value and third academically."

(Pamela W. Turner, S.M.'71, Director of Recruitment and Placement at the Sloan School, said the mean starting salary for Sloan School students graduating with master's degrees in June, 1975, was $19,000, a figure she believes is the highest for any business school's 1975 graduating class. The salary range for June, 1975, Sloan masters graduates was $10,000 to $30,000.) □

$1 Million for Medical Engineering

The Matsushita Electric Industrial Co., Ltd., of Osaka, Japan, will now be associated with M.I.T. programs seeking "economically sound and wiser use of technology to achieve urgently needed advances in health and medicine."

The quotation is from the announcement of Howard W. Johnson, Chairman of the Corporation, of a $1 million gift to M.I.T. from Matsushita; it will fund the Matsushita Professorship of Electrical Engineering in Medicine.

A goal of the Professorship, says Mr. Johnson, is "international collaboration on urgent problems of common concern to two countries that are leading in the application of advanced technology to human welfare." Masaharu Matsushita, President of the Company, spoke in his part of the announcement of the "wide range of medical problems common to both of our countries" to which electrical engineering should be better applied.

Matsushita is a major Japanese electrical equipment manufacturer whose products are known under the brand names of Panasonic and Quasar in the U.S. and Canada, National in most of the world, and Technics throughout the world. Medical technology and instrumentation are a major corporate interest.

To celebrate the founding of the Matsushita Professorship, Howard W. Johnson, Chairman of the M.I.T. Corporation and Akira Harada (right), President of the Matsushita Electric Corp. of America, admire the antique abacus used by the late Haryosh Mori, a member of the Class of 1877.

X-Ray Astronomy for Scientific Literacy

The first optical observatory in the world planned primarily to support x-ray astronomy was dedicated late last fall at Kitt Peak, Ariz. It's the McGraw-Hill Observatory, made possible by gifts of McGraw-Hill, Inc., and the Alfred P. Sloan Foundation to a consortium of Dartmouth, M.I.T., and the University of Michigan.

Why an optical observatory to study invisible radiations from space which never penetrate the earth's atmosphere? Because x-ray astronomers, whose satellite-borne instruments have now been perfected so that x-ray sources can be pinpointed to within one arc-minute in the heavens, want to know what those x-ray sources look like in visible light (*for a stunning example of this "multi-media" principle in operation, see page 22*).

But why x-ray astronomy at all?

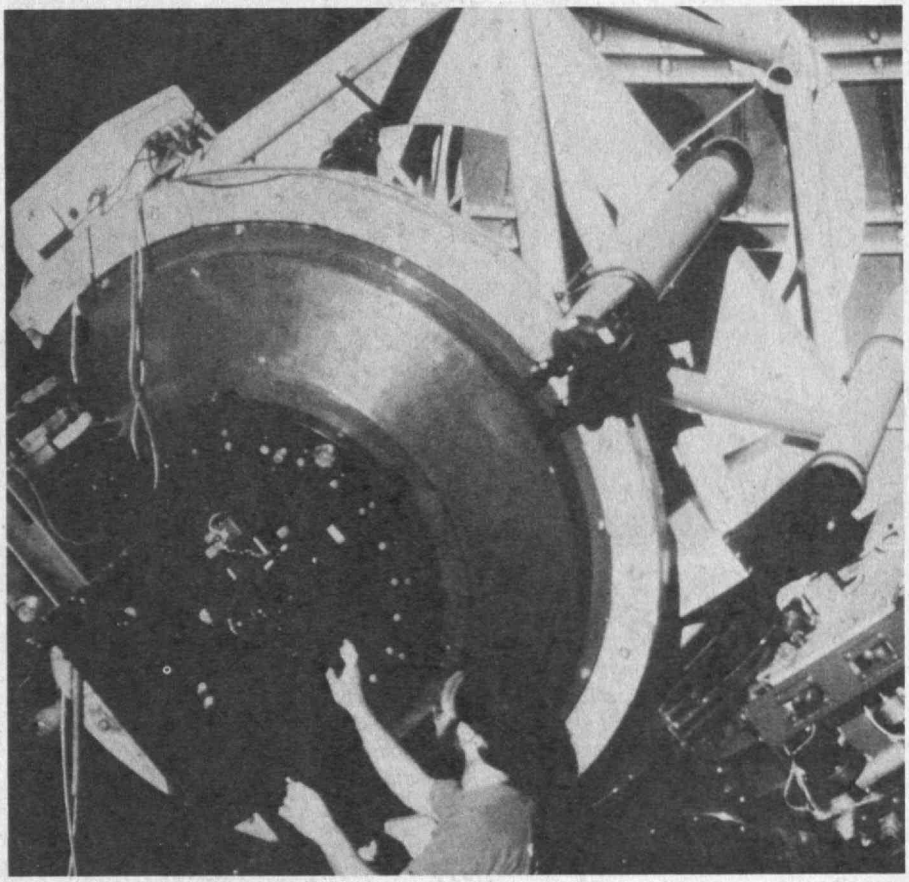
Because, said Walter A. Rosenblith, Provost of M.I.T. speaking at the dedication ceremonies in Tucson on November 15, science offers both "extrinsic" and "intrinsic" values, and you never know which will show up, or when. This is what J. Robert Oppenheimer meant when he said, "New knowledge is useful, and the getting of it is ennobling."

Molecular biology has obvious "extrinsic" as well as "intrinsic" values: its understanding is clearly important to improved clinical medicine. The practical value of x-ray astronomy is not so obvious, nor so assured, thinks Professor Rosenblith. But even such an "intrinsic" science should have "extrinsic" value for all mankind: "a basic scientific literacy," said Dr. Rosenblith, ". . . a common model of our understanding of knowledge and its evolution." So basic scientists owe a "tithe" to the public — an obligation to evaluate their projects and to communicate about their work and their ways of achieving it.

Harold W. McGraw, Jr., President of McGraw-Hill, Inc., joined Professor Rosenblith on the side of the "extrinsic" values. He lamented an accelerating decline in funding for basic science: "We are threatening that flow of new perceptions and insights that have been the ultimate source of our gains," he said.

"We need now to renew our faith in basic research and our commitment to its support," said Mr. McGraw; his company's support of the observatory represented "at least a token of our own convictions on this subject."

The principal instrument at the McGraw-Hill Observatory is a 52-inch reflecting telescope which was previously located near the University of Michigan, where weather and sky conditions are inferior to those of Arizona. In a building adjacent to the domed Observatory itself are a laboratory and shop, computer room, library, and living accommodations for astronomers on 24-hour duty. A computer-based spectrograph for analyzing the light from the telescope, designed and built at M.I.T. last spring, is now installed in the laboratory. □



Harold W. McGraw, Jr., President of McGraw-Hill, Inc., posed with the McGraw-Hill Observatory's 52-inch telescope during dedication ceremonies at Kitt Peak, Ariz., in November. An earlier photograph (right) shows Doron Bardas, '71, working on the spectrograph that is part of a sophisticated computerized observing and analysis system attached to the telescope; Mr. Bardas designed the instrument as a graduate student at M.I.T. (Photos: McGraw-Hill, Inc., and Tech Talk)

Students

If you're frustrated because there isn't time for your hobbies as well as your work, you need an Independent Activities Period. On this and the opposite page are three examples: ceramics, in which Professor William D. Kingery, '48, taught students to form and glaze (the regular Introduction to Ceramics course was prerequisite); tap-dancing with Arlene A. Rozzelle, '79 (left in the picture opposite, whose students said they found her course "fun, different, and good exercise"; and carpentry in the Hobby Show, where Marie Wise, whose husband is a graduate student, worked on a room-divider/bookcase. (Photos: Calvin Campbell and Mark H. James, '78)

I.A.P.: Main Show and Sideshow at Once

Step right this way, folks — learn something you've never had time to learn before. Take and develop photographs, understand the best numerical method for solving partial differential equations, learn to juggle, or to use machine tools. Perhaps you would like to study circus arts, the psychological and technical world of color, the use of genetics in insect control, or graphic design and darkroom techniques? I.A.P. has it all . . .

Exchanging Calculators for Kitchen Ladles

If you — like many students — are addicted to "snack" foods — pizzas, hamburgers, and subs — you should know about the "hundreds of ways" to improve their nutritional value," says Karen Brothers, '68. She teamed with Louise Silver, '68, to teach "Cooking: Good, Easy and Nutritious," aimed largely to help students enhance the flavor of protein, sodium, vitamins, niacin, riboflavin, and a host of other recommended daily allowances. Sample recipes: liver creole, tuna à la king, campfire stew, peanut butter cookies, cheesecake from cottage cheese, and granola bars.

The idea grew out of their computer-based nutritional evaluation company, Consultus, Inc., of Wayland Mass. Operating from a PDP-8 mini-computer in the Brothers' den, the service is offered on a licensing basis to nursing homes, newspapers, and individual consumers interested in recipe nutrient analysis because of dietary restrictions.

Even dormitory residents found the course useful. Freshman Bob Stall and Bob Dawson said they prefer cooking their own meals in the bright new kitchens of New House because they don't expect to eat out every night when they eventually have apartments of their own. Hence the interest

in the I.A.P. course.

It paid off for at least one student. Joel Orleu, assistant to the Provost, says his advisee, Bob Klein, took the course, and now he's "shopping with definite menus in mind and buying vegetables like turnips and broccoli." The I.A.P. course, says Dr. Orlen," could have widespread effects on the entire university community." □

Book Lovers

The gospel according to the library: it's nice to own books. The Humanities Library I.A.P. Book Collecting Contest rewarded some students who agreed. Judges looked for coherence and a sense of purpose, rather than quantity, to determine prize winners.

The $75 first prize (out of 19 entries) went to Henle James, graduate student in mathematics, for ten books he called "American View of the Philippines." "The aim of the collection," he writes, "is to detail American attitudes towards the Philippines from 1898 to the present. The main focus of the collection is on the issue of Philippine independence and the Philippine War. These attitudes represent perhaps the first popular foreign policy debate in the United States, and the character and scope of both the debate and the war foreshadow America's later conflict in Vietnam." Mr. James' collection is "one of the best I have seen," said Jay K. Lucker, Director of Libraries.

"Kites: a High Flying Collection," won second prize. The collector, Theodore Kuklinski, a graduate student in electrical engineering, feels kites are "a unique combination of history, art, science and recreation."

Third prize went to David Herwaldt, a junior in architecture, for his collection on photography; Greg Paris, graduate student in biology, received honorable mention for his collection "Books About, and by, the Inklings (at Oxford)", and Guy Nordenson, a junior in humanities and science, was cited for honorable mention for his collection, "The Ezra Pound Era: Early 20th Century English Poetry." □

Journey Into Fantasy

I was told I must participate when I arrived, intrigued, at the Circus Arts Workshop.

Eight of us walked around the small room. Someone would name a type of character — and we would change our manner: I was ancient, with a cane; a tall, lithe, joyful basketball player; uncomfortably obese; then slightly tipsy . . . In twos, we mirrored each other. I felt relief when I took my partner's place to be imitator instead of initiator . . . We practiced juggling with three elusive lacrosse balls.

The hardest part was the skits. We sat in a circle. David A. Mark, '73, pulled your prop from a sack (or you could find your own), and with only a moment's thought, it became part of your invented scenario. A stick of wood became a flute in a marching band, then part of a drum, then a bass fiddle bow. A jump rope became a snake, dancing to the exotic pipe music of its cross-legged master. A sequined old-fashioned lady's hat was transformed into a cowboy hat, its owner on horseback, lassoing ornery cattle.

My turn was coming . . . I wanted, most, to sneak out the back door. Out of the bag came a little blue and white striped hat. I accepted it with panic.

But when I put it on, I became a golf player, struggling under the weight of a heavy golf bag, carefully selecting my club, placing the ball just so. As I got ready to swing, one member of the circle in my line of sight was already ducking. . . . — *M.L.*

"If You Come Home Late, Mother Will Have a Heart Attack . . ."

When you say no, do you feel guilty?

You're in your office and it's going to be an extremely busy day. Your boss is on edge. Your friend Jane stops by to chat . . .

What is your reaction?

Deanne Rosenberg, who gives lectures on assertive behavior, describes and labels three responses to such a situation at the Women's Forum:

— You take time to talk (and get all worked up, sweating, hating your friend — hating yourself.) Your nonassertive behavior leaves the other person in the dark and you without self respect.

— "Hi Jane, I feel awful today. My stomach hurts, I have a headache, I came in late because the subway broke down, my boss is angry . . ." (She is sorry she stopped by to see you.) Your aggressive behavior gets your point across, but the victim feels belittled.

— "Hi Jane, I'm glad to see you. (You like her and want her to know it.) But I'm very busy (the truth). I can talk for only two minutes." (She doesn't feel rejected; you're not anxious.) You're being assertive when you stand up for your rights in a way that doesn't make the other feel bad; when you command respect.

It all started when you were tiny. "We're set up to feel guilty and anxious," says Ms. Rosenberg. "You come home late; your father warns you your mother will have a heart attack." People exerted power over you, and you quickly learned countermanipulation tactics.

The goal of assertiveness training is to be able to handle manipulations so you respect yourself. The other person respects you too — and knows where you stand.

You're doing more and more tedious, mindless work in the office – but you don't complain, you just put in longer hours. You have your eye on an opening coming up that would be a promotion . . . But you don't get it. You go into the boss's office. "I thought . . ." And he says, "Oh, I thought you liked doing that stuff."

If you change your actions today, says Ms. Rosenberg, your feeling about yourself will change and the attitude of people *toward* you will change.

Your friend phones. "Would you drive by Logan Airport this morning and pick up my mother-in-law?" You don't want to. Why can't he? But he is your friend. What are friends for? Maybe he'll hate you. But you wouldn't ask him . . .

What would you do? — *M.L.*

Lectures, Seminars, and Classes: the Heart of the I.A.P. Experience

Student comments about the Independent Activities Period, as recorded by *The Tech:* "Generally I take courses I'm interested in, and do some reading on my own" . . . "It's the only time at the Institute when you don't have to go to class . . . the only time when this place feels at all human" . . . "I would be very upset if they took I.A.P. away from us."

Here is a sampling of the lectures and seminars they are talking about, as offered by members of the faculty during January, 1976 — a rich harvest of wisdom on subjects at the frontiers of technology and its social implications:

Contained Fusion Plasmas — six 1½-hour lectures by Professor James E. McCune

Energy from the Wind — 2-hour seminar by Professor Rene H. Miller

The Aircraft Wake Turbulence Hazard — two-hour seminar by Professor Shiela E. Widnall, '60

Birth of a Building — eight 2-hour meetings with Professor James M. Becker and architects and contractors for the 60 State Street Office Tower, Boston — including construction site visits

The Salt Marsh Ecosystem — all-day field trip to the Greater Sippiwissett Salt Marsh ("boots required," said the announcement) led by Professor Eugene Bell

The Use of Genetics in Insect Control — lecture series by Professor Linda M. Hall

Petroleum Refining and Synthetic Liquid Fuels — four 2-hour lectures by Professor Charles N. Satterfield

Technological Change in the Chemical Industry — three lectures by Jordan J. Bloomfield, Ph.D. '58, Senior Research Specialist, Monsanto Co.

Policy Analysis Experiments with Urban Travel Demand Models — an opportunity for students to use several urban demand travel models developed at M.I.T. by Professors Moshe E. Ben-Akiva and Steven R. Lerman

Railroad Systems Planning — lecture series by Professor Joseph M. Sussman, Ph.D. '68

Oceanography — all-day visit to the Woods Hole Oceanographic Institution with Professor Tanya M. Atwater

Resource Potential of Deep-Sea Manganese Nodules — lecture by Professor Roger G. Burns

Chemical Evolution of the Earth's Crust and Mantle — lecture by Professor Stanley R. Hart, '56

The Impact of Oil Decontrol — lecture by Professor Jerry A. Hausman

Empirical Research in Macroeconomics — research with Professor Robert E. Hall "satisfying the requirements for an econometrics term paper"

Materials Aspects of the Energy Problem — nine 1½-hour lectures organized by Professor Mildred S. Dresselhaus

A Slot-Car Traffic-Surveillance Simulator — construction of a laboratory simulation tool to monitor the passage and speed of vehicles, with Paul K. Houpt

Russian for Travellers — practice conversation sessions with Professor Catherine V. Chvany

Current Directions in Artificial Intelligence — lecture series by Professor Patrick H. Winston, '65

Options and Problems of Energy Alternatives — two-hour lecture by William J. Jones

Accelerated FORTRAN — "as much about the FORTRAN languages as the class can assimilate"

Introduction to Multics — three 2-hour meetings on storage, access controls, and programming

Magnetic Fields and Energy — five lectures at the Bitter National Magnet Laboratory

Models for Energy Planning — three 1½-hour lectures by Professor Jeffrey H. Shapiro

The Alcator Experiment and Physics of Thermonuclear Plasmas — two 2-hour lectures by Professor Bruno Coppi

Earthwatch — experience helping interpret three years of microwave and infrared observations of earth from space with Professor David H. Staelin, '60

Raman Spectroscopy and Membrane Structure — all-day colloquium of the Spectroscopy Laboratory

Resource Recovery from Wastes — work with Professor Michael B. Bever, Sc.D. '44, on an eddy-current separator to recover nonferrous metals from solid wastes

Dynamo Theories of the Earth's Magnetic Field — three lectures by Professor Michael R. E. Proctor

Machine Shop Practice — opportunity to use a wide variety of machine tools for metal-working in 12 3-hour sessions with Professor Stephen P. Loutrel, '65

Atmospheric Predictability — ten 2-hour lectures by Professor Edward N. Lorenz, Sc.D. '48

Energy Conservation in Industry — five 2-hour lectures, including one by Congressman Mike McCormack of the House Committee on Science and Astronautics

Vehicle Motions in Storm Seas — three 2-hour lectures and a session at the Ship Model Towing Tank by Professor Martin A. Abkowitz, '40

Particle Physics for the Uninitiated — three lectures by Professor George Brandenburg

Tintinnabula

"You're either hooked right off or you can't see how anyone could enjoy it. . . . It's like a taste for anchovies or riding horses."

Ruth Cross, '76, makes a valiant effort to explain her passion to a somewhat doubtful audience. Bells are meant to ring a tune — "Faith of Our Fathers" on Sunday morning. So what is this clamor of sounds but the work of rank amateurs, or of some wildly energetic child loose in the belfry?

Ruth is a member of a fledgling band of M.I.T. change-ringers, and the art she and her fellows practice is one of the oldest forms of bell-ringing. For centuries it has also been one of the rarest, supplanted 300 years ago in every country but England by the upstart carillon, a Dutch invention. The carillon consists of stationary bells struck by clappers. It is played from a keyboard, and is no less melodic than the piano.

The change-ringer has no use for such felicities. His bells are mounted on wheels and swing 365° at the pull of a rope. The heaviest bell is the tenor, typically weighing 2,500 lbs., and the lightest, the treble, is no object of scorn at close to 700 lbs. Hence, a steady "bong . . . bong" is all that can be managed — but the music is by no means simple. And it's surprisingly sweet, the result of striking the bells mouth up and out.

"And Then Ding Dong"

The source of change-ringing's appeal — to the ringer if not the inexperienced listener — is its demand for physical and intellectual precision. Steven Spura, '76, the M.I.T. group's ringing master, believes change-ringing's mathematical derivation "makes it the perfect music."

The bells are numbered, from as few as four to as many as 12, and rung in sequences of nearly infinite variety. The simplest sequence is "rounds": a descending scale in which the bells ring in order, one after another. "Changes" are worked by varying the order, at most one place at a time for each bell. So a slightly more complicated sequence might run: 1-2-3-4-5-6, 2-1-4-3-6-5. Extended changes are called "methods," and by memorizing them, a ringer can be sure of the path his bell must take when a change is called. Or reasonably sure. Thousands of methods have been devised and new ones are constantly invented. They are put to good use, for one of the rules of ringing is that no fewer than 5,040 changes be rung in a peal, none of them repeated. This requirement commits the ringer to a good three hour's work, and encourages quite a thirst. One English ringing jug dated 1827 is inscribed:

When I am filled with liquor strong
Each man drink once, and then ding dong.
Drink not too much to cloud your knobbs
Lest you forget to make your bobbs.

Rope Tricks

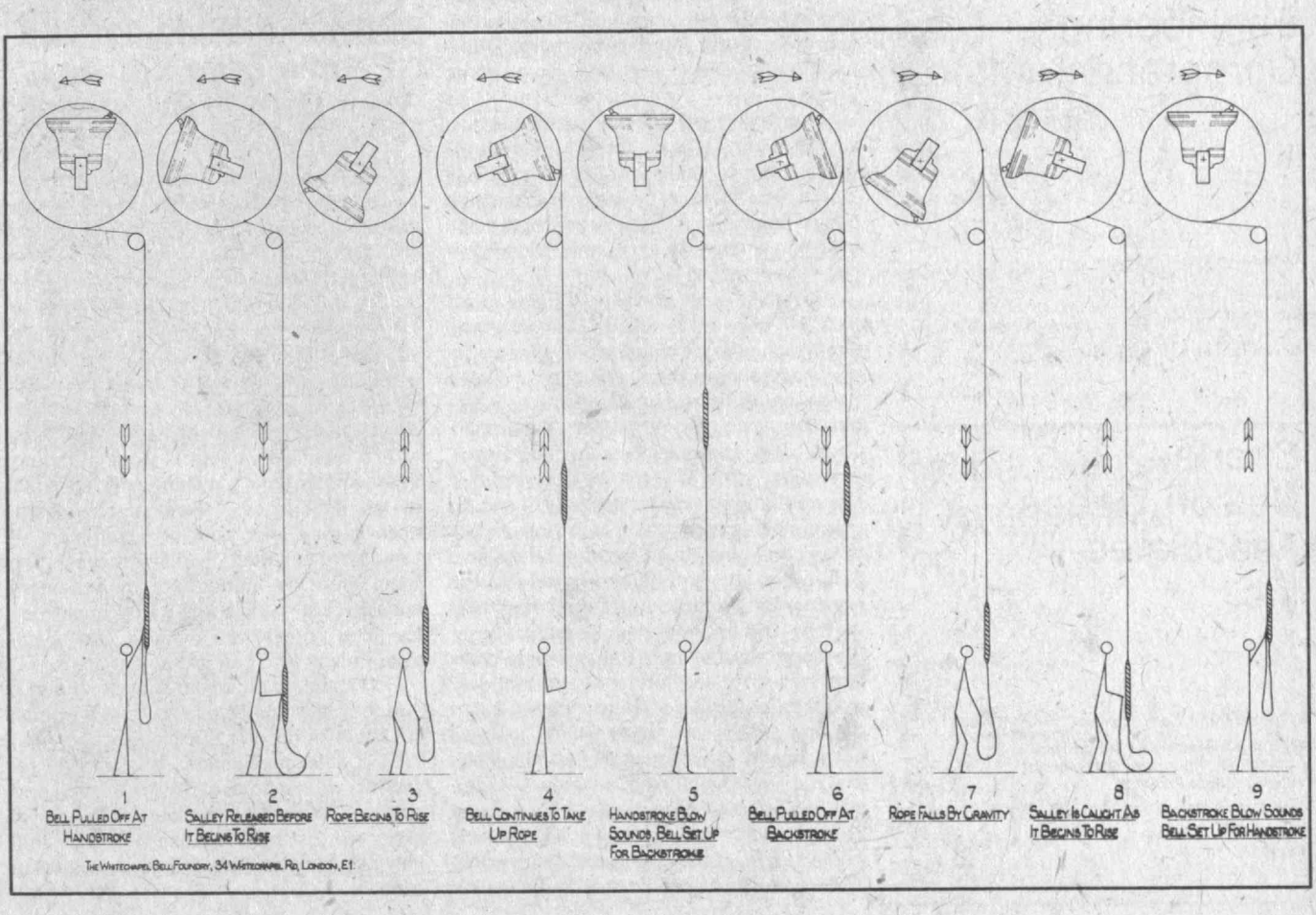
Change-ringing is difficult enough for the soberest of spirits. During the Independent Activities Period a year ago, the change-ringing class — 15 strong — spent three hours a night, four nights a week learning to

handle the bells. Ruth Cross says most difficult to learn was a "rope sight": "You *have* to watch the ropes. If you wait to hear the bells, you'll be thrown off sequence since there's a delay between the pull on the rope and the sound above."

The next step was to win admission to the North American Guild of Change-Ringers and join more seasoned ringers at Boston's Church of the Advent, one of 18 bell towers equipped for change ringing in North America Geoffrey Davies, the Advent ringing master, member of the Ancient Society of College Youths (England's most prestigious ringing society), and a professor of chemistry at Northeastern University, was full of suggestions. He proposed that the students campaign for a bell tower at M.I.T., buy their own handbells, even cast a set of tower bells. "After some of those ideas, the prospect of forming a club sounded trivial," Ruth says. "So I got the necessary information, wrote a constitution, and the M.I.T. Guild of Bell-Ringers was founded."

With the last I.A.P., the Guild's membership has grown to 18 with enough underclassmen to make the club's future reasonably secure. Ruth Cross and Steven Spura are excited about the club's latest coup: having swelled the Church of the Advent's ringing chamber past comfort, the M.I.T. ringers are moving to the Old North Church ("one if by land , . ."), whose bells are older than any in the U.S. by 100 years. They have not been heard since the 1930s. — *D.McG.*

"The art of change-ringing is peculiar to the English, and, like most English peculiarities, unintelligible to the rest of the world. To the musical Belgian, for example, it appears that the proper thing to do with a carefully-tuned ring of bells is to play a tune upon it. By the English campanologist, the playing of tunes is considered to be a childish game, only fit for foreigners; the proper use of bells is to work out mathematical permutations and combinations. When he speaks of the music of his bells, he does not mean musician's music — still less what the ordinary man calls music. To the ordinary man, in fact, the pealing of bells is a monotonous jangle and a nuisance, tolerable only when mitigated by remote distance and sentimental association. The change-ringer does, indeed, distinguish musical differences between one method of producing his permutations and another. . . . But what he really means is, that by the English method of ringing with rope and wheel, each several bell gives forth her fullest and her noblest note. His passion — and it is a passion — finds its satisfaction in mathematical completeness and mechanical perfection, and as his bell weaves her way rhythmically up from lead to hinder place and down again, he is filled with the solemn intoxication that comes of intricate ritual faultlessly performed." — Dorothy L. Sayers, *The Nine Tailors*, Harcourt Brace Jovanovich, Inc. (Photo: Michael Feirtag, '72)



Once Upon a Time . . .

The queen sat by an open window, mending her husband's shirts. As she gazed past the dark panes, she pricked her finger, and on the snow fell a drop of blood. She thought to herself, "I want a child with skin as white as snow, with lips as red as blood, and with hair as black as ebony." When the child came, she named her "Snow White."

Folk tales have more to do with myth than with childish entertainment, more to do with stark subconscious expression than with elaborated fiction. In her "Folktale Workshop," Claire J. Kramsch, Lecturer in Foreign Literatures, explored the common themes in European tales with an emphasis on their richness and their ambiguity. Beneath layers of sugar coating, the tales' dark realities emerged — often to the shock of a class nurtured on Disney's celluloid fantasies. The deep wood holds terrors no sorcerer can summon, no fairy can banish. — *D.McG.*

James Michael Curley: Then and Now

"Where are the James Michael Curleys of Today?" was the topic. The speaker: Boston Mayor Kevin H. White, concluding an I.A.P. series of seminars on "The City in the Age of Machine Politics," organized by Assistant Professors Martha Weinburg of Political Science and Robert Hollister of Urban Studies.

"I would suggest that there could not be a James Michael Curley today," said Mayor White. "The complexity of Curley is difficult to assess. There is no debate that some people loved him blindly; others hated him blindly. Our task is to do neither; but to view him in perspective.

"We must understand the society in his time. He grew up in unique political conditions during the emergence of the Irish after they had suffered years of injustice." Mayor White told of legendary stories he heard — but they came from another generation. Then, "one week after I was elected mayor, it all came back in a roar; I understood in one paragraph all my father told me and his grandfather told him. I was giving an address and I wanted to see what others said before me, so I got the addresses of other mayors. Every speech said the same thing — they thanked the people profusely for electing them, talked of the awesome problems to face in the future — and that they would go on to solve them together. But in the mid-1800s, one mayor said that we have among us a faction of the population that will never be infused in our own, whose children will be ignorant, who will be found living in filth. He was speaking about a whole section of the city — and those words drove home to me the poverty and rejection of the Irish. Curley never forgot — it became part of his character."

Mayor White analyzed this character: humor, garrulousness, sympathy, combativeness to survive, a rebellious spirit against injustice. He was a loner; there was an arrogance about him, a sense of the theatrical. Sometimes Curley would overdramatize. But a willingness to listen — the personal touch, was there. "People had a *feeling* that Curley represented a pulse, a beat, a motion of the people," Mayor White emphasized. "Curley will be remembered for his prominent personality."

The politics, people, press, and expectations are different now, said Mayor White. Curley's courage and his willingness to fight are missed in our politics today, when there is great timidity. We've been made sad and cynical by our colorless leaders. But our attitude toward leadership, too, has changed. Charismatic leaders are desired — and feared. There is suspicion that if a leader is charismatic we will lose. (It's no accident, these men have been shot down.)

"The real value in studying Curley is not his contribution or role as a boss or his performance as mayor. It is that he represents the traits — both good and bad — of the Irish character," concluded Mayor White. "To know Curley was to know the Irish. You ask if there are Curleys today? You will find them in Belfast." — *M.L.*

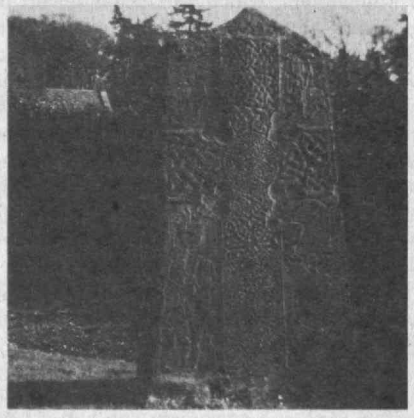
Women in Politics: "People Take You at Your Own Assessment"

"Many are not used to seeing a woman in a position of authority. But I view that as *their* burden, not mine. That has its own force and momentum — it frees me of becoming a zealot," Delores Mitchell, Executive Secretary to the Governor and Cabinet, told an I.A.P. seminar on "Women in the Political World." That doesn't mean she is not concerned. "I utilize my position so equal opportunities for women are not forgotten." She feels the single most productive source to find qualified women is word of mouth. When she looks at a resumé, she looks first at job experience. "Management experience is very important for government — even more important than law school." She feels there is inadequate management capacity, but "people who want to make policy (idea people) are hanging from every tree. People who can implement are rare."

One standard argument against women is "we think it would be nice to have a woman but there is no one qualified for the job." With a little imagination, Ms. Mitchell responds; we don't have to think in such narrow lines. Women can be found with a mix of skills; we just have to take a chance that they can transfer their skills to a new discipline.

"My own observation of the cabinet is that individual and personal differences loom far larger than sex differences. People who are competent are respected for competence," she said. "I find by and large people take you at your own assessment. If *you* assume you have to be mealymouthed, submissive, subversive rather than straightforward, *you* have a problem," she concluded.

Ann Gannet, representative from Wayland, feels a woman will be questioned far more extensively before a legislative committee than a man. "I think men have less of a conscience in the legislature than women do. I wonder," she mused, "if women were adequately represented they would be just like men. But women are essentially timid about running," she added. "The climate today is good for women running for public office. And we have begun to build a cadre of people who have had significant government experience and can't be ignored." — *M.L.*



"One can see as much variety of landscape in six hours crossing Scotland as in six days crossing the United States," says Ellen Henderson, M.I.T. Assistant Professor of Chemistry. Her slides and commentary on her three-year tenure as a postdoctoral researcher at the University of Edinburgh were an I.A.P. feature. Dunotter Castle (top) is naturally moated by sea and cliffs — the only access is by bridge. Below is a 10th century Pictish stone in the manse garden at Glamis. — Sandra Knight

The Riddle of Memory

Memory: some have it, some don't.

Why? The answer eludes even the best psychologists and physiologists. But in ignorance may be the seeds of enlightenment, said Hans-Lukas Teuber, Professor of Psychology, whose lecture on "The Riddle of Memory" held an I.A.P. audience spellbound for two hours.

Dr. Teuber found a visual metaphor the best way to explain the memory process. Think of a mansion, he said: each floor represents a topic to be remembered, each room a subtopic, the furniture and decorations within the room the particular details. The memorist methodically "walks through" the mansion of his memory, stopping when the correct information is retrieved. This space-time allegory was used by the ancient Greeks when they taught the art of memory, and it still works today, Dr. Teuber noted.

Research on the memory itself can be described in three levels of increasing difficulty. On the first level, the when, how, and where of memory is questioned — what determines if an experience is retained; what parts of the brain preserve information and thus are essential to "proper" memory functioning. On the next level are animal experiments. Knowledge of the destruction of memory traces has been gained by studying the vulnerability of memory to electrical shock, chemical inhibition, and surgical removal of brain tissue. From memory facilitation experiments has been learned how certain conditions — e.g. food deprivation and alcohol excess — affect memory.

We know less about tagging the "traces" of memory — but current work with radioisotopes is leading to the isolation of memory's biochemical nature.

Finally, the most difficult area is the transfer of memory from one organism to another. Some elementary experiments with goldfish suggest that memory involves a change in RNA. Having undergone training for a simple task, the brains of fish in various stages of learning were ground up and analyzed: their RNA composition at the various stages was different.

(At this point, Teuber stirred his audience by imagining a futuristic technique at Walker: if memory is discovered to be transferrable via RNA, RNA of learned people might be replicated and given to students in their commons meals. An M.I.T. education thus might consist of eating your 8.02 and 5.41 for dinner.)

Scientists have studied human subjects who have suffered concussions, received stimulation or damage in certain regions of the brain, or experienced amnesia. From these cases exclusive combinations of pre- and post-trauma memory recall have been observed.

Concepts of memory storage and retrieval presuppose a modular theory of memory. For example, might RNA units correspond to the memory bits of electromechanical cybernetics? Are some units of memory lost, or simply "crowded out" by others when one tries to recall them? — *Melissa M. Weiksnar, '76*

Politically Dead Campus? But for Some, "125 Per Cent Fervor"

By Michael D. McNamee, '76

When Thomas Mayer, a Dartmouth student studying at the Institute last fall, set out to do a story for *The Tech* on campus organizing by "presidential hopefuls," he came back dismayed and confused.

"This is the deadest campus, politically, I've ever seen," he said. "Nobody even seems to have any idea that there's a campaign for President of the United States going on!"

Apparently the 13 or 14 "hopefuls" running for President at that time agreed with Tom, because his research turned up only one candidate — U. S. Senator Birch Bayh — who had set up any kind of organization on the M.I.T. campus. Bayh's staff was convinced that college organizations "are the backbone of our local Boston area operation," and had put a lot of effort into reaching even "apathetic" M.I.T. The other candidates hoped to get to M.I.T. soon, but apparently were busy dealing with Harvard and Boston Universities, the University of Massachusetts, and so forth.

Tom has finished his M.I.T. work and gone back to Dartmouth, where he regales his friends with anecdotes showing that M.I.T. really is — and isn't — like all those stories you hear about the place. As I write this, he's busy planning coverage of the New Hampshire primary for his own paper, *The Dartmouth,* and radio station, WDCR; happily surrounded by politics-watchers in a highly politicized state, he still can't get over how apathetic — apolitical — M.I.T. students seem to be.

There have been changes on campus in the three months since Tom left, as M.I.T. slowly catches the political fever that reportedly has infected the rest of the country since August. The Massachusetts primary on March 2 made it impossible for any candidate to ignore schools as large as the Institute, and signs of political life are beginning to show here.

U. S. Representative Morris Udall spoke for the second time at M.I.T. on February 5, the first of four candidates who accepted the Lecture Series Committee's invitation to address M.I.T. audiences. Booths for Udall, former U. S. Senator Fred Harris, and Bayh have joined the Musical Theatre Guild's ticket salespersons and Alpha Phi Omega's booksale in the Building 10 lobby. Buttons proclaiming support for one "hopeful" or another have started appearing on lapels, and bumper stickers are being imaginatively applied to backpacks, bicycles, jackets, and even bumpers.

Despite these developments, however, political debate at M.I.T. is at best only a low rumble, peaking in some parts of the Institute — the Political Science Department, for

Standing room only for Morris K. Udall in the Sala de Puerto Rico just before the Massachusetts primary. (Photo: Owen Franken, '68)

one, has a small pool going for the student or faculty member who comes closest to guessing the New Hampshire results — but for the most part drowned out by the ever-present noise of problem sets, quizzes, classes, parties, and "hacking" — the day-to-day life of M.I.T. students. It wouldn't take most observers long to accept Tom Mayer's conclusion that "this is the deadest campus, politically, I've ever seen."

Overall, they would be right. But just as it would be unfair to talk about the "average" M.I.T. student — chemical engineer or economist? anti-military radical or R.O.T.C. cadet? campus leader or reclusive academic, or both? — it doesn't pay to talk about "overall" campus attitudes. There are hot spots of political activity at M.I.T., and many of those spots are very hot, indeed — so hot, one observer thinks, that there may well be more political activity among students now than there was during the campus activism period of the late 1960s and early 1970s.

"There wasn't as much regular electoral-politics activity on this campus in 1968 or '72 as there is this year," Robert Schaeffer, '72, said. "The activity is certainly more straightforward, more public, and more 'regular' — that is, more involved in the standard political system, rather than extra-political movements."

Schaeffer has observed two previous presidential campaigns at M.I.T. — as an undergraduate and McCarthy volunteer in 1968, and as a McGovern campaigner in 1972. This year, he's splitting his time between graduate study in Political Science and staff work for CPPAX — Citizens for Participation in Political Action, an issue-oriented liberal group which has enjoyed a great deal of success in aiding candidates in Massachusetts races. Since most of his undergraduate years were during the activist "Time of Troubles," it was surprising to hear him say:

"I wouldn't be the least bit surprised if there were more political activity — I think it's just spread out more. There aren't the super-dedicated people there used to be. Instead, a broader segment of students is working in the campaign, in less-visible but equally important ways."

Schaeffer attributed the increased interest he saw in the campaign to "more students' belief that electoral politics are the legitimate way to bring about social change." The activist students of four or eight years ago, he said, weren't likely to work for candidates because many of them viewed standard politics worthless. "As I've read youth goals through the years," Schaeffer said, "the actual goals of today's students aren't that much different from those of a few years ago. What's changed is the view of political actions and processes."

Whether numerous or few, the M.I.T. students who are involved in politics this year are bringing their own stamp to the campaign. In addition to supplying doorbell-ringers, envelope-stuffers, and button-wearers, the Institute has launched several projects which involve students in the presidential extravaganza in some unorthodox, if not unusual, ways. The program that has gotten the most attention, on and off campus, is the Political Science Department's News Study Group study of how the press covers the campaign — a "hall of mirrors" in which students watch and videotape the press watching and filming the candidates.

"It's fascinating — there's a lot going on, an interaction between the candidates and the press that really makes you wonder who's running the show," Ian "Randy" Wilson, '76, an economics major, said. "It's been a lot of fun, but it's a little disillusioning, too."

The project, which was dreamed up by graduate student Tom Piper and Political Science senior lecturer Edwin Diamond, sends teams of M.I.T. students equipped with videotape cameras into the New Hampshire hustings to watch the press and television correspondents. Interest in the program has been sparked by recent books and articles on how the press covers politics, but the M.I.T. plan is the first to involve videotaping news crews in action.

"It gets really strange some times," Wilson said. "The networks are concerned with the same questions, so one weekend I found myself taping three film crews that were all filming each other. Four cameras, all pointed at each other — it was surrealistic!"

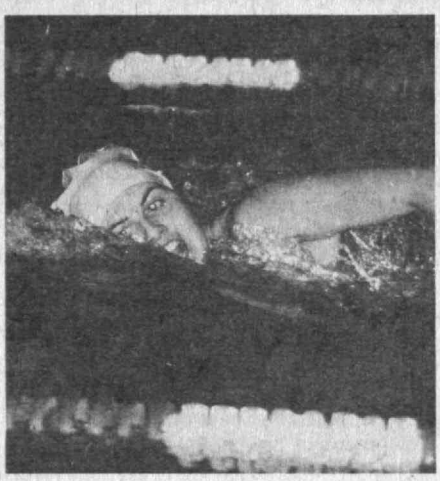
The study has had a few problems, the most notable being some crews' desire to film candidates, not the press. Wilson said, however, that he kept his camera pointed on the reporters: "Why be the 408th person to watch Jerry Ford when you can be the first person to watch the press and record what they're up to? I'm more interested in press/candidate relations than in the candidates." There are also some differences of opinion on how to use the study's results; Wilson asks, "Are the big-shots of the business, especially the TV networks, going to accept criticism from us? I think our criticisms will be valid, but I don't know how well they'll be implemented."

The group's conclusions will be reported in journalism reviews, and a videotape collage summarizing the experience is in the works. But more important than the conclusions, "godfather" Diamond feels, is the exposure the students are getting to the political process: "These kids are getting into all the campaign functions, they're seeing first-hand what's happening, and they're getting a real lesson in what makes politics tick. For many of them, it's been really eye-opening."

Randy Wilson, for one, has been profoundly influenced by his first political experience. "I had absolutely no interest in politics before this project — I came into it because I was interested in video, using video to explore relationships. I'm still not into politics heavily, not supporting any one candidate, but I'm much more aware of it now." And the effect has had at least one result: "I registered to vote for the first time today," he told me.

What would Tom Mayer find today if he came to M.I.T. to find the political action?

Nine out of ten students, it seems, wouldn't want to talk politics — but the tenth student would bring a 125 per cent fervor to his political work that would at least shake up Tom's conclusions about M.I.T. apathy. Many other students, he'd find, are ingeniously applying the political atmosphere of the season to their own needs and interests — studying video use by studying the press, for example. The volume of political activity might not drown out the noise of everyday life at M.I.T. — and probably never will — but where M.I.T. students are involved, their commitment is likely to be total. That's the way it usually is here. □



"What do the male athletes think about the women athletes?" asks David A. Dobos, '76, in the adjacent column. Occasionally respect, more often uneasiness, sometimes downright intolerance, he answers. Budget shortages don't help; men tend to see the co-ed newcomers as competitors for funds that were already too short; hence the women's fund-raising campaign — special T-shirts (left, below) for $3.50 each (readers may order them from the Review*). But just wait . . . "A mutual respect and comradery" are inevitable as the women's teams develop, says Mr. Dobos. Those are already obvious on Burton House's co-ed crew (top), shown rowing hard in the intramural Class Day event last fall. (Photos: David H. Green, '76, David A. Schaller, '78, Daniel F. Lam, and Calvin Campbell)*

Women Athletes: Tolerance or Respect?

Sports Desk
David A. Dobos, '76

A lot has been said and written about the recent impressive gains in women's athletics at M.I.T. But one dimension has been neglected: what do the male athletes think about the women athletes?

The men and women see each other regularly, and the men are necessarily more than casually aware of the women's teams. The increasing women's participation has caused a squeeze on already-overcrowded athletic facilities. Many women's teams must practice with the men, and some displace them entirely during conflicting practice hours. The oarsmen and oarswomen share the Pierce Boathouse, and the two gymnastics squads share the same equipment. The men's basketball team is forced to practice at least two days a week on the du Pont Gymnasium courts instead of on the Rockwell Cage game court because the

women feel that they should have equal access to the best facilities. All this means that the men have had to look seriously at women's athletics.

Many men feel that, although the women put in long hours, they do not work as hard as the men. The men finish practice with perspiration-soaked uniforms and aching muscles. The women seem not quite so wearied. The men feel that they place much more emphasis on winning, and they work harder toward victory than the women.

If some of these attitudes are unfair, there is at least some justification for the men's frustrations. A man who has been brought up with the idea of working hard to excel at a skill and has competed for hard-to-win places on athletic teams since grade-school little league has some reason to think his attitudes toward athletics are more "masochistic" than those of his woman counterpart who has just recently stepped onto the threshold of the athletic experience. The men view women as infringing upon a formerly masculine-dominated area; they feel on the defensive. Old-fashioned male chauvinism conflicts with the idea of equal access for both sexes to all facilities.

But M.I.T. women are beginning to establish themselves as athletes. Women's teams won 54 per cent of their contests in 1974-75, compared to only 45 per cent for the men. Women have proved to everyone that they are serious about participating in athletics on a permanent basis. They are committing the necessary hours to practice and are improving rapidly. They are learning that to win consistently they must push themselves beyond previous endeavors. The women's volleyball club is a prime example. M.I.T. won the Massachusetts state championship last November after the team had spent no less than two hours a day of hard practice since the beginning of September.

When women first started athletic club teams at M.I.T., many men considered the whole thing a joke or, at best, a feeble effort that would disappear as most passing fads. Women lacked the commitment to practice daily, work hard, and to improve. Women did not take themselves seriously and the men were not about to.

Now it's different. Women are establishing themselves as athletes at M.I.T. There are now eight varsity women's teams — three of them recommended for that status by the Athletic Association and approved by Ross Smith, Director of Athletics, in February. The 20-per-cent participation in intercollegiate athletics by women is not only an all-time high; it puts them slightly ahead of that of the men.

As men's and women's teams are exposed to each other, athletes of both sexes will develop a mutual respect and comradery. In increasing numbers, men's and women's teams together will travel to or host other colleges' respective squads. In the 1976 season, four of the eight gymnastics meets will involve the teams of both sexes. Given time and increased dedication to her own improvement, the M.I.T. woman athlete will earn her male counterpart's unqualified respect.

Indexing the Life and Times of M.I.T.

"A good index is a work of art, a thing of beauty, a useful tool forever," says Professor E. Neal Hartley, Institute Archivist. And if *The Tech* does indeed, as Paul E. Schindler, '74, proposes, "set the course of discussion and debate at M.I.T.," then clearly Professor Hartley's enthusiasm for Mr. Schindler's index is justified: "It translates a very useful record into a precious historical resource," said Professor Hartley late last fall when he was presented with 100,000 lines of computer print-out which constituted an index to *The Tech* for the decade 1960 to 1970.

It is the first unit completed of a comprehensive index to *The Tech*'s first volumes. There are 69,500 entries, compiled at a cost of $15,000. When he started the project, Mr. Schindler (he was Editor of *The Tech* in 1973 and now is reporting for the United Press in Boston) estimated a complete index to *The Tech* might cost $10,000; now he thinks another $40,000 are needed to finish the job, and he is busily seeking contributions to add to the $3,000 which *The Tech*'s alumni have provided so far.

The ceremony was an occasion for nostalgia as well as tributes. James R. Killian, Jr., '26, Honorary Chairman of the Corporation who edited Volume 45, said he "made friends that are still friends — very real, solid fellowship" and had "experiences that I cherish very much." Indeed, Dr. Killian credits his career at M.I.T. to *The Tech*: as *The Tech*'s Editor he was asked by Harold E. Lobdell, '17, and Eric Hodgins, '22, to cover undergraduate affairs for *Technology Review* and subsequently was invited to join the *Review*'s staff.

The Tech "has contributed a real continuity to M.I.T.," he said, "a substantial increment to the quality of life at the Institute," and he remains "proud of having been part of it."

Where can *The Tech* have its greatest influence? As "an important factor in keeping the administration and faculty informed of responsible student views," thinks Alex G. Makowski, Jr., '71, who was associated with *The Tech* during the stormy years of student activism. The fact that it "preserves the student point of view" seems to Mr. Makowski the most important service of the index.

The fact that The Tech *"sets the course of discussion and debate at M.I.T." gives the paper "an awesome responsibility," thinks Paul E. Schindler, '74. Hence his concern to make its contents accessible through a master index, the first decade of which he presented to Professor E. Neal Hartley (right), Institute Archivist, at a dinner this winter. Among the guests were Alex G. Makowski, Jr., '71, who recalled his own experiences as Editor in the period of student activism, and James R. Killian, Jr., '26 (at Mr. Makowski's left in the picture below), who traced his late 50-year career at M.I.T. to a* Technology Review *assignment when he was Editor of* The Tech *in 1925. (Photos: Thomas F. Klimowicz, '77)*

The Tech: Bombshells and Eggshells; Order Out of Chaos

"No pay, very little recognition, and usually just lots of trouble," is one staff member's description of life at *The Tech*. And he loves it.

Pizza and coke bottles are all over the place Sunday night at *The Tech* office. Deadline is approaching. One editor is on the phone asking a freshman with 18 tests the next day to take a story he thought interesting (for somebody else) — this is called "stroking."

Another is screaming about what happened to a story he just gave out.

There's 30 or 40 inches to go, and the Editor-in-Chief turns to the prolific people: "Say, what was that terrific idea you had?"

Someone explains that there is a dark art known as making news: "The editor goes into a room and strange noises come out . . . news at *The Tech* is not necessarily things that happen . . ."

"Everyone here has a title," says Mark J. Munkacsy, '78, this year's Managing Editor, but what work you do is determined entirely by what you want to do; how much power you take." Michael D. McNamee, '76, last year's Editor-in-Chief (now Feature Editor) adds: "When we are functioning well, ads and news keep a continuous flow (more like a sporadic spurt.) But we spend so much time worrying about incoming stories that the outflow of ideas loses."

Each editor colors the paper by his choice of assignments. Mr. McNamee says he tried to approach the Institute and the news in a more serious manner — less undergraduate news, fewer sophomoric articles on dorm hacks. He thinks there should be more coverage of city and university ("town-gown") relationships.

"Most students treat Cambridge only as a place where they happen to live and shop. City groups resent M.I.T. . . . Last spring I wrote an article disagreeing with the Cambridge City Council resolutions on the use of the Simplex property. I felt that if Cambridge turned over to the kinds of things envisioned by these people, it wouldn't be worth living in. In response, 17 people from a Cambridge action group had a mass meeting with us in *The Tech* office. But we didn't hear each other.

"Sometimes we drop what we think is a bombshell, and it sounds like an eggshell. And sometimes things that don't seem important at first, become so. It's a strange community, it doesn't go by ordinary rules. If we're assailing the administration for something heavy, and if it's something students can *feel*, then students will follow. We love controversy, but we don't think it has to center on our criticism of the administration. We disagree with student government, too." (Anger from the administration or students over an article can be expected about once or twice a semester.)

The news comes from many sources. "We have to think about trends," says Mr. McNamee. "My most useful tool is the *Chronicle of Higher Education*. I look for science topics that are not necessarily M.I.T. news, but of interest to the community. And anything that happens at M.I.T. is grist for our mill. We have rumor mongers . . ."

He feels that news must be presented fairly. "Sometimes there's an atmosphere of approbation or disapproval that we're running a story. A journalist can't write a news story without some coloration — it's a question of setting up norms."

Newcomers have the opportunity to learn. "We start by sending a reporter to a seminar," Mr. McNamee explains "but before long that becomes just a job. A serious story (on how the dorm presidents feel about what the Dean is doing, perhaps) is moving a step beyond. The reporter has to think of the questions himself.

"It's harder to get more serious stories, like biohazards and their effects — by doing such stories we gain more as a paper, and personally the reporter can gain much more confidence as a writer. But it's harder to think of thinking assignments — and it's all too rare that the reporter has his own idea of a project — although we think we encourage it."

New writers tend to make a basic mistake, says Mr. McNamee. When reporting a seminar, they look at what is happening (sequence, setting) rather than at what information is being presented. "When editing a story, I look at the style, clarity, and bases touched." Organization and headlines are very important — "we must grab the reader as he is scurrying down the hall."

The Tech informs. ("I know more about this from *The Tech* than from anything else," said President Jerome Wiesner of one important Institute issue at a recent news media briefing.) It enriches student life. ("Without *The Tech,* there would be less consideration of other things besides the grind," says one student.)

And it has profound influence on some students — those who wander into *The Tech* office as hesitantly curious freshmen and eventually turn from their original major to seek careers in journalism. "It meant more to me to be at the newspaper than in class," says Paul E. Schindler, '74, former Editor-in-Chief who is now holding down a United Press job as a State House correspondent in Hartford, Conn. Mike McNamee says his life has been changed immensely by *The Tech.* "I expected to be a math professor. Now I want to be a journalist." — *M.L.*


The Tech

CAMBRIDGE, MASS., TUESDAY, FEBRUARY 11, 1936

Haymes Orchestra Selected to Play For Junior Prom

Boxing Team Ties Rutgers College; Shut Out by Penn

The Tech EXTRA

"Let's Set The Rising Sun"

ADUATION SET FOR APRIL 27; MPTON CALLS OPEN MEETING

TECH

CAMBRIDGE, MASS. FRIDAY, JAN. 7, 1949 PRICE FIVE CENTS VOL. LXIX NO. 1

VOLUME 69 NUMBER 1

ecutive Committee es Insurance Plan nance Reunion Gift

Champ, Benenson, Rubin, Reiner Form The Tech Managing Board Other Promotions Announced

The Tech

Burton, EC get squeeze next year

"overcrowding can be done."
— Greg Blaunder
Dormcon Chairman

Throughout its 95-year history, The Tech's *typography — as well as its news — has mirrored the times. A new "logo" and new "heads" (left) appeared this February, with the opening of Volume 96.*

People

Blake, Edwards, and Wheatley Complete a New Alumni Staff

When you want to reach into M.I.T., reach for your Regional Director.

Two Alumni Association staff members are starting their work in this capacity, and a third is now starting work as Director of Conferences and Special Programs. As a result, the roster of the Alumni Association staff is now complete for the first time in 1975-76.

The new Regional Directors:

— **Robert D. Blake,** formerly Special Assistant in the Office of the Secretary of the Institute, is Regional Director for New England.

— **Joseph Edwards,** '72, former Legal Adviser to the Chief of Yale University Police and Assistant Professor of Criminal Justice and Political Science at the University of New Haven, is Regional Director for the southeastern states.

— **Nancy J. Wheatley,** '71, formerly Assistant Dean for Student Affairs at M.I.T. who had a brief tenure as Regional Director for New England, is now Director of Conferences and Special Programs and Assistant to the Executive Vice President of the Association.

Messrs. Blake and Edwards join Stephen P. Denker, '59 (metropolitan New York, New Jersey, and Philadelphia), Daniel J. Fingerman, '69 (midwest), and Ronald S. Stone, '59 (West Coast), as Regional Directors. Mr. Edwards succeeds the late Martin M. Phillips, '47.

Ms. Wheatley has been at M.I.T. since graduating in physical science, serving one year as Administrative Assistant in the Unified Science Study Program before joining the Dean's Office. Her recent responsibilities there involved the Undergraduate Seminar Program, the Freshman Advisory Council, Residence/Orientation Week, housing, and counseling. Her decision to join the Alumni Association, Ms. Wheatley told Thomas Mayer, '78, of *The Tech,* results from meeting "a lot of alumni who I really liked as people, and who had come back to M.I.T. because they liked students."

Mr. Blake studied at Dartmouth (A.B. '65) and is a candidate for the M.B.A. degree at Boston College; in the Office of the Secretary he has been responsible for the staff support of M.I.T.'s 28 Corporation Visiting Committees and the 18-member Corporation Joint Advisory Committee (C.J.A.C.), of which he was Executive Secretary.

Mr. Edwards studied political science at M.I.T.; then attended the Yale Law School (J.D. 1975), where he specialized in interrelationships between legal and political systems; and has recently passed the Massachusetts bar examination. □

Leadership Campaign New England Officer

Support of the M.I.T. Leadership Campaign in New England will be the responsibility of Edith E. Nelson, who has joined the Institute's Resource Operations staff as New England District Officer.

Her assignment is to work closely with alumni leaders in identifying and soliciting alumni, friends, foundations, and corporations for major gifts to the Campaign, says Kenneth S. Brock, '48, Director of Resource Operations.

Ms. Nelson, a graduate of Elmira College, has spent her career in the financial field, first with the State Street Bank and Trust Co., where she became Administrative Assistant to the Vice President and Head of the Mutual Fund Division; later as a member of the Administrative Staff of Massachusetts Financial Services, Inc.; and most recently with a small Boston investment and banking firm where she was in charge of research on venture capital and corporate finance projects. She is a registered principal of the National Association of Securities Dealers.

Ms. Nelson will work with alumni and Campaign prospects in all six New England states except Fairfield County, Conn.; her headquarters will be at M.I.T. □

R. D. Blake

J. A. Edwards

N. J. Wheatley

E. E. Nelson

Individuals Noteworthy

Fellows

New Fellows of the American Institute of Aeronautics and Astronautics: **Leonard Jaffe,** '39, of the National Aeronautics and Space Administration; and **George T. Upton,** '45, of L.T.V. Aerospace Corp. . . . **A. Craig Hood,** '50, General Manager of the Special Products Division of Standard Pressed Steel Co., a Fellow of the American Society for Metals.

M.I.T. Changes

Melvin H. Chalfen, Director of the Radioactivity Center, to Assistant Medical Director in charge of the Environmental Medical Service . . . **Donald B. Johnson,** Assistant Director, to Associate Director of the Development Office . . . **Alfred R. Doig, Jr.,** S.M. '76, formerly with Energy Resources Co., Cambridge, to Industrial Liaison Officer.

Wendy C. Irving, '77, who wants to work in environmental design after graduating from the School of Architecture and Planning, is a contestant for *Glamour* Magazine's Top Ten College Women of 1976 — a nomination by her boyfriend, she says.

Helen F. Whitaker, widow of Uncas A. Whitaker, '23, is a Life Trustee of the M.I.T. Health Sciences Fund. Mrs. Whitaker shared her late husband's interest in the life sciences at M.I.T., and their endowment together made possible the Whitaker Building in the 1960s; the Health Sciences Fund supports medical students and collaborative medical research at M.I.T., Harvard, and Boston-area hospitals.

Counselors: Officers, Directors, and Advisors

Lawrence C. Turnock, Jr., '41, to President of the American Iron Ore Association . . . **David R. Whitehouse,** Ph.D. '59, to a member of the New England Baptist Hospital Corp. . . . **Roger H. Wingate,** S.M. '37, General Chairman for the $1.2-million capital campaign of the Melrose-Wakefield (Mass.) Hospital . . . **Wallace B. Crowston,** S.M. '59, to Dean-elect of Faculty Administrative Studies of York University . . . **Robert Alberty,** Dean of the School of Science at M.I.T., will chair a subcommittee on the interpretation of science to the general public for Boston's Museum of Science; **Raymond Baddour,** Lammont Dupont Professor of Chemical Engineering at M.I.T., and **Julius Stratton,** '23, President Emeritus of M.I.T., will assist on that committee . . . **Margaret MacVicar,** '65, Associate Professor of Physics at M.I.T., is a member of the Boston Museum of Science committee to study classroom programs for younger students.

Kudos: Honors, Awards, and Citations

To **John B. Goodenough,** Leader of the Electronic Materials Group at Lincoln Lab, a Centenary Lectureship of the Chemical Society of Great Britain . . . to **Don G. Friedman,** Sc.D. '54, the Award for Outstanding Contribution to the Advance of Applied Meteorology of the American Meteorological Society . . . to **Hoyt C. Hottel,** '24, Professor Emeritus of Chemical Engineering at M.I.T., the 1975 Royal Society Esso Award for Conservation of Energy . . . **William J. Harris, Jr.,** Sc.D. '48, Vice President of the Research and Test Department of the Association of American Railroads, named the railroad industry's 1975 Man of the Year by the editors of *Modern Railroads*.

To **John C. Ruth,** Sc.D. '67, the Meritorious Service Medal of the United States Air Force . . . **Richard B. Marsten,** '45, Dean of the School of Engineering at City College in New York, cited as one of America's "Adult Educators of the Year" by the Committee on Social Justice of the national Association for Continuing and Public Adult Education . . . **Simon Wilke Freese,** '21, honored by the establishment of the Simon W. Freese Environmental Engineering Lecture by the Board of Directors of the American Society of Civil Engineers . . . **George S. Schairer,** S.M. '35, to Honorary Fellow by the Fellows of the American Institute of Aeronautics and Astronautics.

Victor F. Weisskopf, Institute Professor Emeritus and Professor of Physics Emeritus at M.I.T., one of seven scientists appointed

to the Pontifical Academy of Sciences by Pope Paul VI; and also elected President of the American Academy of Arts and Sciences . . . **Alan Perlis,** Ph.D. '50, and **Robert C. Seamans, Jr.,** Sc.D. '51, were among the eight scientists chosen by the Commerce Department's National Bureau of Standards to assess the current state and future of science and technology in their 1976 Distinguished Lecture Series.

Fellows

Patricia Cumming, Assistant Professor of Literature in the Department of Humanities at M.I.T., received a $5,000 fellowship from the Danforth Foundation . . . **Gerald C. Pomraning,** Ph.D. '62, was elected a Fellow of the American Nuclear Society . . . **Martin C. Jinschke,** Ph.D. '68, a White House Fellow for 1975-76 . . . Five to receive North Atlantic Treaty Organization Senior Fellowships in Science: **Arthur M. Poskanzer,** Ph.D. '57; **Karl Seff,** Ph.D. '64; **H. Henry Stroke,** Ph.D. '55; **Malcolm L. Gefter,** Associate Professor of Biology at M.I.T.; and **Harvey M. Sapolsky,** Associate Professor of Political Science at M.I.T. . . . **Raymond F. Baddour,** Sc.D. '51, Lammont duPont Professor of Chemical Engineering at M.I.T., elected a Fellow of the American Institute of Chemical Engineers . . . **George J. Flynn,** '69, has been selected to participate in the Mass Media Intern Program sponsored by the American Association for the Advancement of Science.

Career Changes

David L. McBride, '56, Director of Production Planning and Control of Youngstown Sheet and Tube Co., Youngstown, Ohio . . . **Anthony C. Yeung,** S.M. '73, Assistant to the Vice President for Corporate Engineering of Travenol Laboratories, Deerfield, Ill. . . . **Lawrence M. Casellini,** '58, Assistant Secretary in the Engineering Division of the Casualty-Property Department of The Travelers Insurance Co., Hartford, Conn. . . . **John S. Bethel, Jr.,** '38, who recently retired as Executive Vice President of Metcalf and Eddy, Inc., has formed the new consulting firm of Bethel, Duncan and O'Rourke, Inc., Boston, Mass.

Stanley M. Brown, Jr., '47, Sales Manager of New Britain Machine Division of Littman Industries . . . **Kenneth Hootnick,** '61, General Manager of the Diamond Expansion Bolt Division of General Cable Corp., Garwood, N.J. . . . **Reece H. Wengenroth,** '42, Technical Director of Railroads and Industrial Facilities of the engineering firm of Parsons, Brickerhoff, Quade and Douglas, Inc. . . . **Peter H. Corcoran,** '70, a marketing systems research analyst for Anheuser-Busch, Inc. . . . **Robert N. Maglathlin,** '45, Director of Development Engineering at Raytheon Co.

Robert A. Dennis, '70, joined the Bond Department of the investment counseling firm of Scudder, Stevens and Clark, Boston, Mass. . . . **Peter J. Koros,** Sc.D. '58, Director of Metallurgy Process of the Jones and Laughlin Steel Corp., Pittsburgh, Penn. . . . **Andrew C. Kadak,** Ph.D. '72, Nuclear Information Manager for the New England Electric System of the Narragansett Electric Co. . . . **Ralph A. Groemping,** '75, Research Associate in the economics consulting firm of J. Watson Noah Associates, Inc. . . . **Donald A. Corrigan,** '57, Director of Metallurgy and Research of Handy and Harman, New York, N.Y. . . . **Thomas F. McCabe,** '59, Advanced Projects Director in Operations of New England Gas and Electric Service Corp.

William P. Walsh, Ph.D. '54, Director of Environmental Planning and Management of the Research Corp. of New England . . . **Bernard J. Beaudoin,** '63, Director of Economic Planning of New England Power Service Co. . . . **Norman L. Laschever,** '40, Manager of Electronic Warfare and Radar Programs for R.C.A.'s Automated Systems Division . . . **William R. Moser,** Ph.D. '64, Research Associate in the Department of New Technology at the Badger Co., Inc. . . . **Jack H. Vernon,** S.M. '54, an associate in the international management consulting firm of Heidrick and Struggles, Inc.

Michael D. Van Deelen, S.M. '75, a security analyst for the Putnam Management Co., Inc., Boston, Mass. . . . **Alan D. McWhirter,** '54, manager of a new cooperative arrangement between Combustion Engineering Inc. of Windsor, Conn., and Kraftwerk Union of Erlangen, West Germany . . . **Robert Alperstein,** S.M. '64, Associate in the firm of Woodward-Clyde Consultants . . . **John B. Sutherland,** '49, manager of Fisher Body metal fabricating plants in five cities.

George E. Hecker, S.M. '62, Director of Worcester Polytechnic Institute's Alden Research Laboratories in Holden, Mass. . . . **Donald R. Miller,** '50, now Director of Professional Services for the international management consulting firm of Cresap, McCormick and Paget Inc., in addition to his positions as Vice President and Eastern Region Manager . . . **Jack W. Wolter,** S.M. '74, Vice President of Manufacturing and Engineering for the Construction Products Division of W.R. Grace and Co. . . . **Rutherford Harris,** '37, Assistant to the President of Arkwright-Boston Manufacturers Mutual Insurance Co. . . . **Clarence W. Malick,** '64, Assistant General Counsel and Assistant Secretary of I.T.T. Thorp Corp. . . . **Paul L. McGill,** '51, Commercial Vice President in the Nuclear Power Systems division of Combustion Engineering, Inc.

W. Boyd Hopkins, S.M. '68, Director of Planning and Financial Services of the Corporate Data Processing Department at Connecticut General Life Insurance Co. . . . **Herbert W. Mower,** '65, member of the Special and Scientific Staff of the Department of Therapeutic Radiology at the New England Medical Center Hospital . . . Rev. **John C. Larkin,** '30, Pastor of the Lubec Congregational Christian Church, Maine . . . **Nicholas V. Mumford III,** '70, Production Planning Supervisor in the Production and Inventory Control Department of Burroughs Wellcome Co. . . . **John R. Kearney,** '48,

Manager of Melting Services in the Manufacturing and Engineering Division of Corning Glass Works . . . **Harry B. Doyle, Jr.**, '48, Regional Manager for the Denver office of McGraw-Hill Publications Co. . . . **James H. Heasley**, Sc.D. '64, Senior Research Associate at the Ferro Corporation Technical Center . . . **D. W. Ryckman**, Sc.D. '56, formed the new environmental engineering consulting firm of D. W. Ryckman and Associates, Inc.

Carl M. F. Peterson, 1906-1976

C. M. F. Peterson

Carl M. F. Peterson, '29, Director of Physical Plant from 1954 to 1971, died of an apparent heart attack on January 9 at his retirement home in Green Valley, Ariz. He was 69.

Mr. Peterson was born in Boston and entered M.I.T. from Boston Technical High School; he was associated with M.I.T. continuously from 1925, when he joined the Class of 1929, until his retirement in 1971.

Following completion of undergraduate and master's degrees in mechanical engineering, Mr. Peterson joined the teaching staff in that field. By 1938 he was dividing his time between teaching and duties as Assistant Superintendent of Buildings and Power, and in 1943 he gave up teaching to become Superintendent of Buildings and Power.

Mr. Peterson became Director of Physical Plant in 1955 and during the next 17 years supervised the addition of new construction valued at more than $40 million to the Institute plant. "We came to rely heavily on his leadership, wisdom, and experience," recalls Philip A. Stoddard, '40, Vice President for Operations. During the same period Mr. Peterson became widely known throughout the U.S. academic community; he was President of the Association of Physical Plant Administrators of Colleges and Universities in 1960. □

Thomas K. Sherwood, 1903-1976: Process Chemistry and the "Sherwood Number"

Thomas K. Sherwood, Sc.D. '29, a distinguished chemical engineer who was a member of the M.I.T. faculty for 40 years and Dean of the School of Engineering from 1946 to 1952, died of cancer at his home in Berkeley, Calif., on January 14. He was 72.

Professor Sherwood's undergraduate education was at McGill, and — though he was not a native Canadian — he never lost his devotion to that country. He came to M.I.T. for graduate study in 1923, and even before he completed his doctorate he was a member of the faculty in chemical engineering at Worcester Polytechnic Institute; he returned to join the M.I.T. faculty in 1930.

In 1966, three years before his retirement, Dr. Sherwood was given special recognition with his appointment as the first Lammot du Pont Professor of Chemical Engineering, a chair established by members of the du Pont family as a memorial to Lammot du Pont, '01. Among many other awards, Professor Sherwood held the William H. Walker (1941) and Founders (1963) Awards of the American Institute of Chemical Engineers and the Warren K. Lewis and E. V. Murphree Awards (both in 1972) of the American Chemical Society; he was given honorary degrees by Northeastern University, McGill University, and the Technical University of Denmark.

T. K. Sherwood

Professor Sherwood was a prolific author in process chemistry; he was an authority on mass transfer under conditions of molecular and turbulent flow and on saline water conversion. His colleagues named the "Sherwood Number" in his honor — it is the dimensionless number used in scientific literature to describe mass transfer correlations.

Following retirement from M.I.T., Professor Sherwood joined the faculty as Visiting Professor of Chemical Engineering at the University of California (Berkeley). □

Carolyn J. Wells, 1956-1975

Carolyn J. Wells, '78, who came to M.I.T. in September, 1974, to major in physics, was found dead in her Senior House room on December 12. She was 19.

Ms. Wells entered M.I.T. from Peachtree High School, Chamblee, Georgia. □

Deceased

Carl H. Bangs, '08; November 21, 1975; 164 Redland Ave., P.O. Box 4897, Rumford, R.I.*

Joseph C. Dort, '09; January, 1976; 610 West St., Keene, N.H.

Morse W. Rew, '09; January, 1976; 12000 Fairhill Rd., Apt. 402, Cleveland, Ohio

Henry A. Babcock, '12; December 13, 1975; 1525 Ard Eevin Ave., Glendale, Calif.

Henry J. Welsh, '13; July 19, 1975; 8 Sharon Rd., North Quincy, Mass.*

Walter P. Keith, '14; November 28, 1975; 516 Delaware Ave., Akron, Ohio

Robert M. Linnell, '14; March 5, 1974; 625 East Ave., Pawtucket, R.I.*

Philip C. Baker, '16; December 10, 1975; 40 Oxford Rd., Grosse Pointe Shores, Mich.

George E. Walker, '17; December 25, 1975; 224 Cascade Ln., Palm Beach, Fla.*

Carleton W. Blanchard, '18; January 6, 1976; 445 Mansfield Rd., North Haven, Conn.*

James H. Sullivan, Jr., '18; December 2, 1975; 1 Reed St., Lynn, Mass.

James W. Gibson, '20; August 4, 1975; Brooksville, Maine

R. Brace P. Crawford, '21; January, 1976

George F. Owens, '21; August 10, 1975; 971 Greenway Ln., Vero Beach, Fla.

Gretchen E. Taylor, '21; December 20, 1975; 31 Eliot St., Jamaica Plain, Mass.

E. Randolph Haigh, '22; January 16, 1976; 224 N.E. 24th Ct., Boca Raton, Fla.

Fay S. Lincoln, '22; December 31, 1975; P.O. Box 383, Avondale, Penn.

Albert L. Sargent, '22; January, 1976; 94 Lincoln St., Melrose, Mass.

Alex Taller, '23; December, 1975; Southgate Apt. 203, 3605 S. Ocean Blvd., Palm Beach, Fla.

Albert C. Read, '24; August 27, 1974; 7501 F St., Little Rock, Ark.

Thomas K. Sherwood, '24; January 15, 1976; 17 Senior Ave., Berkeley, Calif.*

Joseph R. Hobbs, '25; January 19, 1976; 21 No. Main St., Williamsburg, Mass.

Irving M. Symonds, '25; November 12, 1975; Apt. 251, Ciaminera De Penole, Monterrey N.L., Mexico.*

Meredith W. Brewster, '26; December 25, 1975; 8 Sunset Ave., Linwood, N.J.

Martin E. Staley, '26; December 12, 1975; 536 College Blvd., San Antonio, Texas.

Karel J. Bossart, '27; August 3, 1975; 6652 Aranda Ave., La Jolla, Calif.*

Carl M. Peterson, '29; January, 1976; 735 La Huerta, Green Valley, Ariz.

Samuel H. Evans, '30; December 16, 1975; Apt. H2, 2501 Palisade Ave., Bronx, N.Y.

Graham Walton, '30; June 26, 1975; 3824 Homewood Rd., Cincinnati, Ohio.

Wallace B. Tibbets, '31; January 1, 1976; 26541 Hempstead Ct., Sun City, Calif.

Meyer A. Baskin, '34; October 25, 1975; 1819 Ferdinand St., Miami, Fla.

William L. Timmerman, '34; October 22, 1975; 15 Crestview Ave., Stamford, Conn.

Edward Lee, '40; January 22, 1976; 370 Fort Washington Ave., New York, N.Y.

Carlton M. Stewart, '41; December 3, 1975; 45 Sylvan Hgts. Dr., Hollidaysburg, Penn.

Peter Whoriskey, '49; November, 1975*

Stephen Waldron, '53; December, 1975; 4229 Mariposa Dr., Santa Barbara, Calif.

Per G. Lagerberg, '55; 1970.

Charles D. Green, '56; November 3, 1975; 240 84th St., Miami, Fla.

Michael E. MacKintosh, '74; January 6, 1976; 804 W. South St., Gallatin, Mo.*

* Further information in *Class Review*.

Class Review

03

Howard Pew II, our distinguished classmate, passed away November 28, 1971. The Pew Memorial Trust gave $1.2 million to establish a fuels research lab, which now comes to fruition in the completion of the new Chemical Engineering building. A section of the building will be dedicated to his memory.

Our obituary notices arrive at times rather delayed as the death of **Adolph E. Place,** of Boulder City, Nevada on Nov. 6, 1972 is noted by his widow.

Our Happy Birthdays this month: **Ichabod F. Atwood,** Topsfield Farm, Mass., February 28, 1882; **Fred K. Lord,** New Rochelle, N.Y., February 5, 1878; **Fred A. Olmsted,** New Canaan, Conn., February 27, 1882. — **John J. A. Nolan,** Secretary/Treasurer, 13 Linden Ave., Somerville, Mass. 02143

07

Roland H. Willcomb of Course III wrote of his activities: "Still enjoying my woods and wildlife above the Hood Canal in western Washington. Much interested in the U.S. Naval Trident Base development near us. Would enjoy a letter from any of my classmates who may remember me." His address is: Box 397, R.R. 1, Silverdale, Wash. 98383. — S.F.

08

We are sorry to report the death of another classmate. **William H. Medlicott,** M.E., of 406 Fuller St., West Newton, Mass., died August 28, 1975 after a long illness as reported by his daughter, Mrs. Richard M. Forbes of Urbana, Ill.

An old friend who worked with me at the Boston Edison Co., **Carl H. Bangs,** M.E., died November 21, 1975. He had served as Plant Engineer for the Celanese Corp. of America at Rome, Ga. His picture and interests may be found in the *Review* of March, 1970. — **Joseph W. Wattles,** Secretary, 26 Bullard Rd., Weston, Mass. 02193

11

Lloyd C. Cooley writes, "On August 27, 1975, Treva, my wife, and I moved into the 22nd floor of a retirement home in Florida with very charming and hospitable people, an excellent infirmary and a prompt and obliging maintenance staff. Such a view and sunsets!" . . . **Roy F. MacPherson** wrote, "Ina broke her hip on a fall. Has since had two heart attacks. I have her home now but not have had much luck finding a good housekeeper. Regards to all the boys!" . . . **W. K. Hodgman** continues to have an office at Hodgman Mfg. Co. and is a director of that company. "Health quite good, drive my car and get around as much as I want to." . . . **Ralph E. Runels** says, "Regards to all! Am still active as a consulting engineer."

Class President, **Howard D. Williams,** hopes to see classmates at the 65th Reunion in June. He has received a few affirmatives already. "Chief" **Irving W. Wilson** of Pittsburgh, Penn., will not be able to make it because his wife is ill. Howard writes, "When 'Chief' retired from active business he had served as Chairman of the Board of the Aluminum Co. of America and was on the boards of other Mellon properties. As undergraduates we were in Osiris, the Tech Show and other activities together."

Edwin Pugsley of New Haven, Conn., died on November 19, 1975, the day after his 90th birthday. He was an assistant secretary and director of Olin Industries, and world-renowned for his knowledge of small arms and ammunition. He leaves two daughters, a son, 12 grandchildren and one great-granddaughter. — S.F.

12

James A. Cook's message is short. "Retired!" he wrote. . . . **J. C. Hunsaker** is living at 10 Louisburg Sq., Beacon Hill, with an Irish housekeeper. He spent last summer at St. Huberts in the Adirondacks trout fishing.

Jonathan Noyes plans to attend the Mexican Fiesta on March 10 to 12 and hopes to see other classmates there. "It will be my sixth M.I.T. Mexican Fiesta and they get better every year. The Mexico City alumni love to entertain the gringos when they come south of the border with song, dance, food, drink and fun."

Write to the *Review* or Jonathan Noyes, 320 Dunn St., Bryan, Tex. 77801, and tell classmates of your activities. — S.F.

13

The holidays have come and gone, with most of our friends returning for several days. It was very strenuous and tiring for both of us. Roz went to the hospital for many tests. She spent about four days there, but nothing serious was discovered and she is home with her usual energy and vigor.

We received a number of holiday cards and notes from our regular correspondents, including the **Brewsters** (**Bill** is doing quite well); and the **Brewers.**

Ken Blake writes: "Hello folks. Just to show you that Maine doesn't have all the pretty scenery. Fortunately, my wife is young enough and spry enough to capture some of the beauty spots. Me, I see them from the car windows but enjoy them just the same. Thanks for your efforts in the alumni ranks."

Jo Mattson says, "It has been a busy year. I was away three months last winter in Arizona and California. Plan to spend a few weeks in Arizona with **Bunny Brett**'s widow, Garnet. Then on to California to see a nephew and his family, and Janet and Frank. Arry 'n Larry are pretty good — Larry's hearing and vision failing. Have a happy holiday."

A card came from the **Henry Gliddens** with this message: "Some time ago I had a six-page letter from **Louis Rosenberg** of Lake Oswego, Ore., who was a special student in Course IV with 1913. He deserted architecture after many distinguished years and went into etching, at which he worked for many years. One London publisher continued publishing them for ten years, which means a tremendous output; 'Rosie' was always a fast worker."

Best wishes were also forthcoming from Marguerite (Mrs. **Prescott**) **Kelly**; Janet (Mattson) and Frank Pillman; and the **Dave Sterns**.

We received a copy of a Boston *Globe* story on **George R. Wallace, Jr.,** entitled "Meet Fitchburg's Fairy Godfather" in acknowledgment of his many gifts and contributions to the City of Fitchburg. We of the Class of 1913 are very proud of you, George.

We received a very interesting letter from **John Welch,** with his change of address (to 6701 N. College, Apt. 311, Indianapolis, Ind. 46220): "Frances and I had our 50th wedding anniversary two years ago. Last February we sold our home rather reluctantly. The usual tasks that go with a house, yard, etc. and unreliable help were getting to be too much. So we are in a good apartment near our old home and are very glad to have made the move.

"Our yearly two-month vacations at Pompano have ended. After 14 years staying at the same group of small cottages on the ocean, I had a severe heart attack that put me in the hospital for nine days and then ten days more at the cottage. Our car was packed to leave, but I played a third round of golf putting on the two 18-hole greens. That finished me off from golf and any further trips to Florida. And now I am content and happy here with Frances. So this is why no more travel or 1913 gathering, much as I would like to go."

We were very pleased to hear from **J. W. Brooks Ladd**: "I am still in good health with few if any worries. This summer I took an 11-week trip to the West Coast, and visited relatives. It was a fine trip but I was glad to get back to Palm Beach, Fla.

"I only attended M.I.T. for the last two years but I would suggest that one day, including the Alumni Luncheon, would probably be all the classmates would enjoy. This year I'm going to my 65th reunion at Harvard, Class of 1911."

We know you have received a letter from our 1913 President regarding the Alumni Fund. We hope that all of our loyal classmates will respond to his appeal.

It is always a pleasure to hear from **Ken Hamilton,** our outstanding baseball pitcher, and we quote: "Found this bill with some old papers. Guess I owe $2.00. Sorry. Hope you are o.k. I'm still alive." . . . **W. G. Horsch** (Jack) writes: "Are reasonably well for our age!"

Good words from **Pete Haynes, Benjamin F. Thomas,** and **Robert J. Tullar,** who adds, "Beulah and I are both well and looking forward to the reunion."

George W. Bakeman writes: "*Quietly Flows the Don* is hardly an answer, but sort of denotes the situation of the Bakemans in Hanover, Va. Reasonably active, better health than I deserve, and still enjoying life. Similar situation with all three daughters and families." . . . **Allen Brewer** expects to spend three or four days on campus with his wife Maurine during the reunion. . . . And it is always nice to hear from the **Larry Harts**: "We are okay here; Jo and her schnauzzer 'Heidi' are fine and enjoying life." . . . After many years, it was wonderful to hear from Dina Coleman, Class of 1916: "I am certainly glad to note that you are still alive and kicking and managing the affairs of the Class of 1913. I have been going to the class reunions, but now every Delt that I know except George Kittredge and you have died. The days at 234 are a long, long way back, and the world today is so vastly different than the world we knew as students I have given up trying to understand."

We just received a notice of **Henry J. Welsh**'s death on July 19, 1975. We have sent a note of sympathy to his family.

Change of address of **Gordon G. Howie** to: Bruce Manor, 1100 Pine St., Clearwater, Fla. — **George Philip Capen,** Secretary-Treasurer; **Rosalind R. Capen,** Assistant Secretary, Granite Point Rd., Biddeford, Me. 04005

14

In a January letter, **Leicester Hamilton** wrote, "In September I moved from 100 Memorial Dr. — and Massachusetts — to Greenbriar Terrace in Nashua, N.H., a few miles from my daughter Jean (Mrs. John B. Stevens). [His new address is: 55 Harris Road, Nashua, N.H. 03060] Greenbriar offers many things, including elevators, laundry service, a whirlpool bath, barber shop, and a central dining room, so that I'm well taken care of. I have not been back to M.I.T. since living here, although it is only 40 miles. Perhaps someday I will. If any of you are in the vicinity of Cambridge or Nashua, I would be so pleased to see you at the Thoms Building. Have a happy new year!"

Alden Waitt wrote in January that the new building of The San Antonio Art Institute, of which he is President and Board Chairman, had been finished and that registrations were being taken for the spring semester to start that month. The building is to be dedicated later, after the furnishing is completed and the grounds are landscaped. Alden described his situation in three words, "Zany days these."

Robert M. Linnell died on March 5, 1974. The class records show only that he was with us in our first three years, was married in 1919, lived in the Boston area for a time, then in Providence, and eventually in Pawtucket.

Ralph D. Salisbury died on October 13, 1975. He spent all four years with us and graduated in Course IV. His career was with several architectural firms, including one in which he was a partner; and also in the Corps of Engineers, in which he was stationed both in the United States and overseas. Since 1950 he had lived in California, where his last address was in Watsonville. In 1916 Ralph married the former Marguerite Scofield. They had a daughter, Barbara; and a son, Ralph, Jr.

If anyone can send me more information about these two classmates, it would be welcome.

Harold A. Mayer has a new address: 3212 W. Wisconsin, Milwaukee, Wisc. 53209. — **Charles H. Chatfield,** Secretary, 177 Steele Rd., West Hartford, Conn. 06119

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The Florida trek of our "northern snow birds" continues. **Jack Dalton** is in Winter Park and although it hasn't reached the advertised temperature down there, there is no snow and ice. . . . **Wayne Bradley** is in Hollywood demonstrating his system for winning at the races. And he's such a nice guy! . . .This year **Jim Tobey** is really suffering at Lake Worth with 30° temperatures and not much sun. Too bad for him.

We plan for our annual class cocktail party and dinner at the M.I.T. Faculty Club here on the afternoon of Alumni Day, June 4. Notices will be sent to you later, but plan on coming.

Former 1916 Class Secretary, **Harold Dodge** sent his annual original card. . . . Nice to hear from **Ray Gladding,** after 40 years of silence. . . . Jack Dalton's Christmas card message was "best wishes and fortitude for the vital part you play in keeping 1915 together." Thanks, Jack. That's my reward for the year. . . . **Phil Alger**'s card was a wedding picture of his grandson and his new wife.

While in New York I phoned **Jerry Coldwell,** who has recovered from his recent eye trouble and is in good shape, but has not driven his car in two years. . . . **Sol Schneider** and his daughter, Janet, who we met at our 60th Reunion, were in London last fall. He noticed that London had changed since he was there in 1904.

Vi Proctor, widow of Dix, 1917, is carrying on where he left off. . . . Alice Anderson continues her gay traveling and at the holidays had just returned from a long cruise to Athens. . . . **Ray Stringfield,** at 84 years, is just a little older than our average age, but keeps going actively, although retired from his business in Fullerton, Calif. . . . Although pretty much confined to home, **Ken Johnson** writes with his usual sense of humor that he and Esther have their "meals on wheels."

Marion and **Vince Maconi** had planned to be at our 60th last June but could not make it. Vince still enjoys the group pictures of our former big reunions. . . . I am glad to report **Archie Morrison** is living comfortably at a suburban nursing home here. We (who are left around here) see and talk to him regularly.

So, plan for June 4. — **Azel W. Mack,** Secretary, 100 Memorial Dr., Cambridge, Mass. 02142

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As we approach our 60th Reunion dates, our classmates are beginning to show more and more interest. Recently we had a luncheon for classmates in the greater Boston area and we had a surprisingly good attendance on a cold mid-winter's day. The following shared in an enthusiastic discussion of preliminary plans for our 60th Reunion: Grace and **Dan Comiskey, George Crowell** and his son, Bruce, Frances and **Paul Duff,** Sibyl and **Ralph Fletcher,** Mildred and **Frank Holmes, Bob O'Brien,** Dorothy and **Dave Patten,** Frances and **Henry Shepard.** We had a marvelous luncheon and truly enjoyed re-telling our experiences at Tech on Boylston St. and at summer camp in Maine. Someone suggested that we should try to get from each classmate his recollection of the funniest incident of his years at Tech and have them available for our 60th Reunion. Think about it and send along your story.

In addition to those present, we heard from **Don Webster**: "Wish I could say yes but it's a 150-mile drive up and back and I'm afraid it is too much." . . . **Theron Curtis**: "Wish we could, but Hope is not able to get around much." . . . **Barney Gordon**: "I will be in Florida. When I return I shall be very glad to come to meet with you regarding any plans for our 60th Reunion." . . . **Doug Robertson**: "I am back home from the hospital. We are interested in our 60th Reunion and I expect I will be able to attend." . . . At the luncheon we heard that **Charlie Lawrance** has returned to the hospital and was making good progress. We also learned that **Earl Townsend** is now in a nursing home.

Since the luncheon, we have mailed a questionnaire soliciting information regarding attendance at our 60th. The first reply we received was a solid "Yes" from Lois and **Charlie Lawrance.** . . . We were sorry to receive a note from **Dick Berger**'s sister notifying us that Dick "is now in the Methodist Home in Shelton, Conn. and unfortunately has lost his sight." We can remember Dick at our 35th when he gave us an informal talk on the cancer-causing aspects of cigarette smoking. We can also remember his striking resemblance to Harry Truman and the publicity attached to his

doubling as Harry S. Truman in local parades and other festive activities.

The early returns of the questionnaire indicate that we will have an excellent attendance. Paul Duff and **Dan Comiskey** have volunteered to write to classmates urging attendance. If we all took it upon ourselves to contact just a few of our classmates, that might be just enough to encourage attendance by some of those who may be "on the fence."

While at our recent luncheon, we received the following telegram from **Francis Stern**: "In 1976, we incidentally celebrate the Bicentennial. Primarily, we celebrate 60 years of Brotherhood, Affection and Closeness of the Best Class that ever got out of the damn place on Boylston Street." . . . We also heard from **Shatswell Ober**: "Sorry can't make the luncheon. I live very quietly at home only doing a few yard chores. No printable stories."

Other interesting sidelights from the luncheon: Dr. Paul Duff continues actively in the medical profession and was scheduled to assist his son, John, in several operations that week. John specializes in orthopedic and reconstructive athletic surgery. . . . **George Crowell** is having some trouble with his eyes but continues to "go to business every day." . . . **Frank Holmes** also continues to be active in his business.

Had a nice letter from **Jack Camp** in which he indicates that he will travel from his residence in Mexico City to our 60th in Chatham in June. . . . Also heard from **Maury Holland,** who was leaving for his "Winter Headquarters" in Fort Lauderdale. He sent us a November, 1975 brochure of Industrial Research Institute, Inc. in which there are a couple of group photographs with Maury in them, and identified as the Founder of I.R.I. . . . Virginia and **Joel Connolly** continue to be world travelers. Their latest issue of "Southwest News" tells of their trip from Tucson, Ariz., to Rome, Athens, Istanbul, Beirut, Teheran, New Delhi, Bangkok, Hong Kong, Taipei, and Tokyo. Included in this issue was a picture of Joel and Virginia riding high on an elephant. They plan to attend our 60th.

Paul Austin writes: "Last fall I took a month off from my job and went to Europe. My wife and I spent a week in Paris, which is always enjoyable, then flew to London for three weeks. We lived in London for a year and a half back in 1956 and '57, when I was with Bechtel. Last October the magazine *Hydrocarbon Processing* published an article I wrote entitled "How to Simplify Fluid Flow Calculations." I am still working for Arthur G. McKee and Company in San Mateo. I enjoy my job immensely. My many years of engineering experience make me quite versatile and I am frequently consulted on small engineering problems." . . . Talked with **Nat Warshaw** on the phone in January. He misses the opportunity to swim daily now that the beach weather has been replaced by snow, ice, and cold. When weather permits, he takes a three-mile walk daily. He misses the routine of going to work every day. Nat attended his Regimental Reunion (W.W.I.) last fall and is looking forward to attending our 60th.

Many of our classmates have written of wonderful memories of associations with **Joe Barker.** At our recent luncheon, Dave Patten spoke of the way Joe "enlisted" Dave for service with the U.S. Navy in World War II. On Friday, January 16, 1976, **Walt Binger, Barney Gordon, Rudi Gruber,** Jessie Brophy and Sibyl and **Ralph Fletcher** attended a Memorial Service for Joe Barker at The Trinity Church in New York City. May he and all our departed Classmates rest in peace.

Keep your letters and cards coming. As **Cy Guething** says, "Keep Breathing." We hope the way will open up for you to be with us at our 60th. — **Ralph A. Fletcher,** Secretary, H. E. Fletcher Co., West Chelmsford, Mass. 01863

Lost Alumnae

Marilynn Bever, '76, is researching M.I.T. women for her oral history thesis. She's trying to locate: Annie Pierce Hale, '07; Mrs. Ruth Maxwell Denny, '08; Mrs. Louisa Hackett, '16; Clara Poppie, '19; Mrs. C. V. Corliss, '20; Mrs. F. Warren, '21; Mrs. E. F. Dutton, '26; and Mrs. M. J. Richards, '26. Write to Marilynn at 26 Thorndike St., Brookline, Mass.

17

The M.I.T. Historical Collections presented a series of nine seminars in January, concerning the Institute's history during Independent Activities Period. Beginning with Jay Stratton's talk on our "Founders' Philosophies," the topics progressed from "Life at Boston Tech" to "The Move to Cambridge" by **Al Lunn** and your Secretary, when slides of the Bucentaur, the Great Pageant, and the Dedication were shown. The range of topics was extensive. All sessions were video-recorded to be used in the M.I.T. closed circuit as well as being available for Club and other meetings.

Word is that **Dick Lyons**' 80th birthday did not go by without recognition by his friends and associates. . . . Cupid has been at work in Virginia with widowers **Connie Coakley** and **Cy Medding** marrying. Cy will be dividing his time between Virginia and San Antonio. . . . On September 19, 1975, **Enos Curtin** performed the following events on standard regulation facilities at the C. W. Post College track: 16 pound shot — 20′2″; long jump — 9′7″. He is 80 years of age, and these marks better the world records as stated by the *New York Times*. Congratulations to all four of you.

The February notes told of our three Class of 1917 Edmund A. Aldrin, Jr. Scholarship Fund students and quoted a letter from one of them, Michael Solis '77. The following letter is from another recipient, Alan Paul Glombiki '77:

"My deep gratitude to you and the Class of 1917 is two-fold: once for your kind words of congratulations and again for the financial support without which I would be unable to attend the Institute.

"I am an alumnus of Culver Military Academy and I chose M.I.T. because it uniquely situates the world's finest engineering school in Boston, one of the most renowned medical centers in the country. As one might guess I am interested in biomedical engineering. I am presently enrolled in the Chemical Engineering Department and doing research with Professor Clark Colton and Dr. Robert Lees at the Arteriosclerosis Center.

"For extracurricular activities I am a member and past recording secretary of Delta Tau Delta social fraternity. I am a member of the M.I.T. Scholarship and Admissions Committee and work weekends as a paramedic in the Institute's Off-Hours Clinic. I have participated in both rugby and junior soccer.

"Though the competition for entrance is extremely rough these days, I intend to apply to medical school at the end of this year. If I am fortunate enough to be admitted, I intend to split my time between a general practice in medicine and cardiovascular research."

In January Alan was among students representing the Undergraduate Research Opportunities Program (U.R.O.P.) at the regular Alumni Advisory Council meeting when members Lunn, **Ray Stevens, Dunning** and **Hunter** with guest Doris Hunter were happy to have Alan join us at our table. Ray Stevens, having had more conversation with Alan, accommodates us with this comment: "Alan Glombiki, in addition to his standard curriculum, joined the Undergraduate Research Opportunity Program and, as one of its outstanding members, was selected to attend the Council meetings with a few others to acquaint alumni with U.R.O.P. In the program, a qualified student may elect to take an independent research project of his or her own choosing, with a researcher off or on campus and a faculty advisor completing the team. Sometimes more than one student may work on the project. Depending on conditions 'credit' may result and even monetary remuneration. The students are necessarily able ones with special initiative and motivation. Over the years over 50 per cent of the student body has been associated with the program.

"Alan's work at this time is on cholesterol through the Center at the Massachusetts General Hospital, one of the world's leading groups in this challenging branch of medical research.

"After up to 16 hours a week on his U.R.O.P. project and the other things his letter mentions, he does not have much spare time. He does get in some skiing, though. We all liked him and take pride in his association with the Class and in the worth of the Aldrin Scholarship Fund."

Three students are sharing in the Aldrin Fund income. The Aldrin Scholar himself, who must be a student in aeronautics and astronautics, is Paul A. Lagrace '78, of Lewiston, Maine.

Cape Codders and others in adjacent south-shore Massachusetts tell of the joys of their year-round golf. Here may be a reason: at year's end at Mattapoisett, one Ray Stevens negotiated a short water hole in novel fashion. His poorly hit ball was headed for the water but it hit a narrow shelf of ice and was on its way to the green. Of course it should have been found in the cup but it went on over the green. Yet some people desert Florida.

With regret the deaths are noted of **Carl E. Geiger, Jr.,** at Floyd's Knob, Ind., on October 17, 1975; Capt. **Samuel J. Ziegler** at Bethesda, Md., on October 24, 1975; **George E. Walker** at Palm Beach, Fla., on December 25, 1975; and **Haig N. Solakian** at Branford, Conn., on January 30, 1976.

— **Stanley C. Dunning,** Secretary, 6 Jason St., Arlington, Mass. 02174; **Richard O. Loengard,** Assistant Secretary, 21 East 87th St., New York, N.Y. 10028

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From **Bob Rowe** came the following: "I had a mild misery all summer in Michigan and came to my winter home in Sacramento for medical advice and treatment. But my personal physician for 30 years had retired because of sky-rocketing insurance. Other doctors are not accepting new patients, and all doctors are planning a strike January 1. So I went to the drug store and bought a few pills at random!" . . . **Sumner Wiley** sends greetings, and adds, "Max, my opinion about government would be quite worthless today and even worse if it were printed. You are doing beautifully with the 1918 column — without philosophy from the boondocks." . . .**Bob Gidley** says, "Keep pretty close to home these days. Three great-grandchildren are doing O.K. Family close by in Dallas. Hear from **Herb Hatch** and **Palmer Giles** at least once a year."

Eaton Clogher writes, "My beloved wife died last February — a magnificent woman. I live alone, and keeping the place in shape keeps me busy. I stay in rather close touch with my former associates, although I doubt at times that they are too happy with my comments. I have no desire to travel, did enough of it in my early days. Between Christmas and New Year, I withstand eight grandchildren from two to twelve years old, a dog, a rabbit, two sons-in-law, a son, and two daughters. My youngest daughter was graduated from M.I.T. in 1963, course IVA. The first of the name graduated in 1893. Of my male grandchildren, only one is a Clogher; he is three years old. If he elects to go to M.I.T. and makes the grade, he will be in the class of 1994. When next you are in touch with **Lenny Levine,** give him my regards." . . . **Stuart MacGregor** adds his bit: "Two days a week in the EKG Department at Bay Pines, Veterans Administration Hospital. Member of the local bicentennial committee. On the executive boards of the Boy Scouts and Cub Scouts." . . . **Elbert Bancker's** greetings are from the sunny south: "We spent the summer in Schenectady and were glad to get back to warm weather in Florida in September. Activities include lots of so-called golf and the Lake Worth Camera Club, of which I am Vice President."

Mique Flett's message is that recovery is slow but still progressing. . . . **Charles Dimock** sends best wishes, and hopes to make the reunion in 1978. . . . I have also heard from **Bertram Jones,** Helen and **Albert Walker, Tom Knowland,** Mildred and **Charles Watt,** and Jean and **Mal Baber.**

Faithful **John Abrams**' year-end message included the first rough draft of the Abrams-Ullrich lawsuit over water rights. Given the news of very little rain in California, maybe the battle is theoretical. Anyway, we are on your side, John.

Harold Weber says he is still an active-retired chemical engineer, and a 50-year member of A.C.S. and A.I.C.H.E. Once in a while, he talks to local groups on the energy problem. Harold adds, "I noted John Abrams was with **Doc Walker** for some time just before he died. As you know, I am a great admirer of Dr. Walker and have tried to keep his memory alive at M.I.T. Of course, he is a myth to the present generation. I think John should be encouraged to write his impressions of Dr. Walker for the Historical Collections. And if he does, I would like to have a copy."

Bill Foster made a recent issue of the *New York Times*. Gerard Smith and he, former heads of the Federal Arms Control and Disarmament Agency, objected to the President's attempts to exempt U.S. cruise missiles from the ceiling of 2,400 allowable long-range offensive missiles and bombers tentatively set in American-Russian talks in Vladivostock in 1974.

It is with much sadness that I read of the death of **Carl Blanchard,** at 80, at his home in New Haven. He was devoted to our class and to M.I.T. We particularly recall the pleasure afforded by his businessmen's band, which Carl brought to several of our reunions. Carl was chairman of the Board of Directors of Wyatt, Inc.; the *New Haven Register* called him "a pioneer in the development of New Haven harbor." One of five children of a poor Massachusetts farmer, Carl attended M.I.T. on a scholarship provided by a state legislator. With his brother Kinson, he founded the Wyatt oil company, the largest independent fuel oil distributor in New England in the 1930s. — **Max Seltzer,** Secretary, 60 Longwood Ave., Brookline, Mass., 02146; **Leonard Levine,** Assistant Secretary, 539 Washington St., Brookline, Mass. 02134

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Our sprightly classmates continue to roam the world. Last summer, **Harold Bibber** visited the Scandinavian countries, Italy, Paris and London which he found as delightful as ever. . . . Gladys and **Foster Doane** took advantage of a Quarter Century Club trip to Turkey and reported a most enjoyable time. They toured the northern section of Asiatic Turkey and the European side, visiting the ancient city of Troy and the battlefield at Gallipoli. . . . **Perk Bugbee** is talking about a trip to Geneva some time this year, and plans to take in the annual meeting of the N.F.P.A. at Houston this spring.

Others heard from recently include **Fred Hunter** of Evanston, Ill., who celebrated his 80th birthday not long ago and is feeling fine. . . . **Sam Schenberg** also remains in good health and is enjoying his many friends in Miami Beach. . . . My list of Christmas and New Year greetings from classmates failed to include **Ned Murdough** who still resides in South Acton, Mass. It is always good to hear from this popular individual who had so many friends in the class.

Perusal of the handsome, new *Alumni Register* discloses the substantial number of our active classmates in Florida. No less than 26 are scattered all over the state. Maybe some enterprising member will organize a Florida class reunion. After our rather rugged winter, we must confess a slight tinge of envy. — **Harold Bugbee,** Secretary, 21 Everell Rd., Winchester, Mass. 01890

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Your secretary wants to thank many classmates and their wives for the warm Christmas greetings sent to Betty and me. Elma and **John Mattson**'s card was entitled "A Year of Whirlwind" and their activities sounded like it: fishing, gardening, entertaining, travel, 55th Reunion planning, conducting and solo performances with brass and voice. Phew! . . . **Phil Coffin** wrote he was going into training for our Reunion in June. . . . Ceil **Huggins** was the artist on their Christmas card this year. Said she, "Don't blame Frank for the drawing — his style is not Grandma Moses. Took some trips this year — a big occasion — our 50th honeymoon. Went to Mt. Pisgah Inn at the top of Blue Ridge, then back to the mountains in October. Highlights: our visits with our daughter and family in Mays Landing, N.J., and our son and family in Charlotte, N.C.; sight-seeing in Old Salem, Williamsburg, and Washington, D.C."

Betty (Mrs. **Norman**) **Patton** writes: "My job continues to bring new challenges and great satisfaction. Doing needlepoint, barjello and a bit of gardening. Spent a delightful weekend driving to New England to visit dear friends from Cape Cod days. Had a bit of a scare in late September when the Susquehanna River responded to Hurricane Eloise and rose to the top of the dikes, but it didn't go over." . . . Betty and **Dugald Jackson**'s Christmas verse covered 1975 travels to Florida last winter, Colorado in June, and their summer in Maine. . . . **Helier Rodriguez** wrote that they had purchased a new condominium in Tampa and were busy finishing it to their tastes, hoping to move in late in January. Their new address is 5020 Bayshore Blvd., Apt. 701, Tampa, Fla. 33611.

We also received cards from Maxine and **Cac Clarke,** Ruth and **Irving Jakobson,** Marianne and **Grant Miner,** Claudia and **Josh Crosby,** Helen St. Laurent, Ann and **George Schnitzler,** Beth and **Whittier Spaulding,** Hazel and **Whitney Wetherell,** and **Ralph Wetsten.**

Assistant Secretary **Sam Lunden** sent along a letter he had received from **Arthur Raymond** of Los Angeles, Calif. Arthur wrote: "It is now 50 years since my connection with aeronautical engineering started at the fledgling Douglas Co. in Santa Monica. My 35 years there — the last 26 as Vice President of Engineering — were busy, strenuous, and exciting. But the 15 years since retirement in 1960 have been scarcely less so. I have kept active as a Trustee of the Aerospace Corp. and the Research Analysis Corp. and as a consultant to the Rand Corp., N.A.S.A., and others. In between times my wife and I did a great deal of traveling all over the world. Our son Stan has presented us with five grandsons and we have two great-grandchildren. In addition we have accumulated a foster family of former foreign students of U.C.L.A., with whom we developed a close relationship during their years at the university. We have been able to visit a number of them in their homes abroad and some came long distances to join in our Golden Wedding Anniversary four years ago. I am now finally retired — about time, too! Twice a year we go to Hawaii and twiddle our toes in the ocean. We are enjoying life immensely." Thanks for a good letter.

A letter from **Irving Jakobson** transmitted the sad news that **George F. B. Owens** of Vero Beach, Fla., died on Aug. 10, 1975 while on vacation in Vermont. George prepared for M.I.T. at the U.S. Naval Academy and was a Commander U.S.N.R. (retired). For many years he worked for the Brooklyn Union Gas Co. from which he retired as Assistant Vice President in 1950. Jake wrote, "I'm indeed sorry George has passed on — he was a good friend and we had many wonderful times together."

Another death reported this month was that of **Gretchen Eichorn Taylor** of Jamaica Plain, Mass., on Dec. 20, 1975. The class extends deep sympathy to the families of these two classmates. — **Sumner Hayward,** Secretary, 224 Richards Rd., Ridgewood, N.J. 07450; **Josiah D. Crosby,** Assistant Secretary for Florida, 3310 Shefield Cir., Sarasota, Fla. 33580; **Samuel E. Lunden,** Assistant Secretary for Calif., Lunden and Johnson, 453 South Spring St., Los Angeles, Calif. 90013

22

In our Institute report we were told that **Donald F. Carpenter** was saluted at the Corporation Luncheon on October 3 by Howard W. Johnson. Don was moving from the status of Life Member to that of Emeritus Life Member, having been a member of the Corporation since 1943. But even before he joined the Corporation, said Mr. Johnson, Mr. Carpenter had been an influential adviser to Presidents of M.I.T., for he was one of those to whom Karl Compton turned when the system of Visiting Committees was designed in the 1930s. In 41 years since then Don Carpenter has been active on five different Visiting Committees. He is also a member of the original Friends of Music at M.I.T. and was a "prime mover" in the effort to achieve the Class of 1922 Professorship. Don started us in our Alumni activities as Class President at graduation and has continued working to accomplish our Class records of supporting the Institute every year. He richly deserves the standing ovation that was given him at the Luncheon.

Lester Clark Lewis, Assistant Minister at the All Souls Church in Washington, D.C., spent three holiday weeks with his daughter in San Rafael, Calif. Les has been at many of our Reunions, and we hope to see him this spring. His newest grandchild is Bryan Kent, but most of his third generation hover in the teens. Lester and Helen Lewis traveled for seven weeks this summer in the northeast United States and Canada, visiting relatives and friends.

Our Class was complimented in the November issue of *Tech Talk,* which told of the Growth Fund to aid Career Development, and described the discussions with Chancellor Paul E. Gray on channeling the income from our endowment to other accounts to augment the original '22 Professorship and maintain the capital of the Career Development Fund. Class President **Parke D. Appel** of Venice, Fla., has said that both the Growth Fund and the Professorship had market values 10 per cent higher than considered adequate to meet their goals. The first professorship was held by Dr. Margaret MacVicar, Associate Professor of Physics. She was sucoeeded by Dr. Joseph Ferreira, Jr., Assistant Professor of Operations Research and Urban Studies.

William W. K. Freeman of Salem, Mass., has written of his professional and home duties as Metrics Specialist at the Tower School in Marblehead. He has a column in the *ITEM*: "Is It A Metric Christmas?" It sounds complicated, but he recommends "Metric Educational Guide" for general reading. He is leading an exciting life as "an old man in a hurry." Bill was a statistician for an insurance company before he taught Latin and math at the Pike School in Andover. And now metrics. He has also written "Think Metric About Weather."

Your Secretary hopes to attend our 55th Reunion in 1977. I will be in Pompano Beach, Fla., from January 15 to March 15 enjoying the sunshine, golf, travel and friends (also some work). . . . **Edward J. O'Connor** (Doc) of North Andover, Mass., expects to complete his consultant contract by June, 1976 with Allied Chemical, to whom he sold Granite State Asphalt Co. in 1972. Ed is keeping up with his golf at Andover Country Club and Delray Beach Country Club in Florida — his handicap is still 11. Ed comments: "Retirement is not too hard to take after working 54 years." . . . **Lloyd A. Elmer** (II) of Madison, N.J., is tutoring 6th grade students in math in a Summit, N.J., school. . . . **Arturo Ponce Canton** of Merida Yucatan, Mexico is Chairman, Board of Directors for Banco de Yucatan, S.A. and Cerveceria Yucateca, S.A. . . . **Samuel I. Zack** of Hollywood, Fla., is completely retired as Senior Vice President and Vice Chairman of the Board of Gunnett Fleming Corddry & Carpenter, Inc., consulting engineers of Harrisburg, Penn. Sam is golfing, traveling, socializing and fully enjoying retirement.

The sympathy of our Class is extended to the family of **Haskins B. Canfield** of Memphis, Tenn. Haskins was a retired Vice President of Dewey & Almy Chemical Co. in Cambridge. He was born in Chicago, grew up in Somerville, N.J., and was graduated from Middlebury College. He received a master's degree from M.I.T. in 1922, served with the Army in World War I, and was active in the Boy Scouts and civil defense work in Belmont. Haskins is survived by two sons and a daughter. . . . We also send sympathy to the families of **Alexander G. Nichols** of Point St. Lucie, Fla.; **William E. Huger** of Atlanta, Ga.; and **Thomas M. Taylor** of Naples, Fla.

We leave you with the admonition "Can spring be far behind?" Good health to you all. — **Whitworth Ferguson,** Secretary, 333 Ellicott St., Buffalo, N.Y. 14203; **Oscar Horovitz,** Assistant Secretary, 3001 South Course Dr., Pompano Beach, Fla. 33060

23

Tom Rounds and Marjorie are on an extensive trip. He asked me to "pinch hit" for him during his absence, so I'm responsible for any errors of commission or omission.

Shortly before Christmas, **Dave Davenport** and Phyllis visited us in Deep River. They were both fine, but Phyllis has since reported that Dave suffered a heart attack and would remain in the hospital for several weeks. She felt sure that his usual cheerful and optimistic attitude would speed his recovery. While Dave was with me he expressed concern over the number of classmates who do not have the Class History, and hoped that someone would come up with a suggestion to solve this problem. Any ideas?

Lem (Lyman) Tremaine called me from Virginia where he was visiting with Roland Black, '24. Lem reports that he and Helen enjoy life to the fullest, and keep on the move from here to there as Lem tracks down clients who want more insurance for nothing. During the past year he has been swamped with figuring the effects of new requirements on all the policies he is handling. He also says that in certain cities he makes better time running than driving. . . . A letter from **Arthur Stuckey** contained his phone number, so I called him in Tucson, Ariz., where he and Helen live. He reads as avidly as he did at M.I.T. Perhaps some of you recall his phenomenal extra reading of undergraduate days. You may also remember that near Christmas of his senior year, he walked into a truck and lost valuable time — obtaining a string of Ds (Deficiencies). A team of classmates was formed to assist him with some overdue drawings, and he graduated with a clear record. His wife, Helen, shows gradual improvement from her rather long period of physical discomfort, and much of his time is spent in making her life easier and happier.

In a letter from **Howard Russell,** he tells of a trip to Bryce Canyon in Utah, an overnight stay at Lake Powell, a tour of Luke Air Force Base and a concert at Sun City. He also visited Montezuma's Castle, Sunset Crater, and the Grand Canyon. Rotary, the Silver Wings of World War I, the Daedalians, and other affairs take much of his time.

It is with a feeling of regret and loss that I report the passing of one of our most distinguished classmates, **John E. Burchard,** who died on Christmas Day, at the Massachusetts General Hospital, at the age of 77. He was born in Marshall, Minn. At M.I.T. he received a B.S. degree in 1923 and an M.S. two years later in architecture. He married Marjorie Walker Gaines and had two children, John Ely and Walker Gaines, and two grandchildren, Marshall and Wendy. After ten years with the Bemis Industries he became Dean of the School of Humanities at M.I.T., from which he retired in 1964. He was author of many books and publications, and earned authoritative status with such publications as *The Evolving House, The Historian and the City, The Architecture of America, The Voice of the Phoenix,* and *Post War Architecture in Germany.* He received many citations and awards, including the Presidential Medal of Merit, University of Minnesota. He was a Fellow of the American Academy of Arts and Science. A number of his classmates will recall his outstanding success as Chairman of the Mid-Century Convocation of M.I.T. at which time Winston Churchill made a splendid address to us at the packed Boston Garden, explaining that he had received no formal education but had absorbed "a few crumbs of learning along the way" of life. This occasion was truly an outstanding event at M.I.T., and is still vivid in my memory. — **James A. Pennypacker,** Assistant Secretary, Long Hill Rd., Essex, Conn. 06426

24

I regret to begin on a sad note — the loss of one of our more illustrious members, Dean Emeritus **Thomas K. Sherwood,** on January 14, 1976, in Berkeley, Calif. He was a native of Columbus, Ohio, and received a B.S. from McGill University in 1923, earning his S.M. in chemical engineering in our Class and his Sc.D. in 1929 after five years teaching at Worcester Polytech and M.I.T. He was a founding member of the National Academy of Engineering and a member of the National Academy of Sciences; a full account of his professional career appears elsewhere in this issue (*see page 95*). The

sympathy of the Class is extended to Mrs. Sherwood and their family.

From Guadalajara, Mexico, we have good news and bad news. **Ru Torres** has been on a three-week boat and bus trip along the Baja Peninsula, Calif., a mixture of deserts, mountains and beautiful oases. There is a new asphalt-paved road, not a speedway, from La Paz to Ensenada, a trip highly recommended for classmates. Ru is studying astronomy at the University of Guadalajara and enthusiastic about the Observatory high on the "Sierra de San Pedro Martir," San Ignacio in the middle of the peninsula has a wonderful climate, clear blue sky and no pollution, making it very restful and excellent for astronomers.

Word has come from **Dick Lassiter** that Ted Simonton died on July 30, 1975, in Guadalajara, to which he retired in 1973. He was with us for three years taking Course V, Chemistry, then worked in the Patent Office in Washington, D.C., while gaining an LL.B. at New York University in 1928. After a period with a patent firm in New York City, he was transferred to Syracuse, N.Y. Eventually he opened his own office in Cazenovia, N.Y., but enjoyed winter vacations in Mexico. The Class joins in condolences to his family.

Ed Hanley, Class Executive Vice President, writes that he and Dolly are fine and looking forward to their usual month in Tucson, Ariz., hopefully much more pleasant than the prolonged zero weather in Pittsburgh. Anticipating **Luis Ferré**'s regaining the Governorship of Puerto Rico, he believes that the '24 Fiesta in that Commonwealth in 1978 would be super.

Christmas and New Year greetings from **Rock Hereford** and Marda tell of their visit to Europe last September. They rented a house four miles east of the cathedral city of Hereford and enjoyed the beautiful English countryside; and were thrilled at the preservation of stained glass windows in Canterbury, Winchester Cathedral, and Salisbury on the Avon. From Edinburgh they flew to Geneva and drove southward in the Alps to Grenoble, Avignon, and Carcassonne and then to France to see marvelous stained glass windows in cathedrals at Bourges, Chartres, and Sainte Chapelle.

Finally, our perennial world traveler and Class Secretary, **Ray Lehrer,** briefly told of his week's visit to the Soviet Union. His group was bivouacked in a prominent hotel where food and accommodations were better than anticipated. There seemed to be no surveillance, and all were free to move around the streets. A bus tour took the group to a city outside of Moscow — name uncertain, as Ray's Russian pronunciation smacks of a Boston accent. A train ride from Moscow to Leningrad was an experience. On their return trip, shortly after takeoff, pervaded by reality, the group in loud voice almost simultaneously burst into "God Bless America!" Dasvwedonya, you all! — **Russell W. Ambach,** Secretary, 216 St. Paul St., Brookline, Mass. 02146; **Herbert R. Stewart,** co-Secretary, 8 Pilgrim Rd., Waban, Mass. 02168

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Thanks are due the several classmates who have sent material to me both directly and through the Alumni Fund.

Yu H. Ku, Emeritus Professor of Electrical Engineering at the University of Pennsylvania, continues to receive honors. On December 15, 1975, he was awarded the "Pro Mundi Beneficio" medal by the Brazilian Academy of Humanities. This award has been established to honor those who are outstanding in different branches of human relations, as well as in cultural and scientific fields.

I am indebted to **Henry Sachs** for a news item from the December 18, 1975 *New York Times*. It reads in part: "Beatrice Feingold Phillips of Boston, widow of Bernard Phillips, was married in Boston yesterday to Henry N. Sachs of New York, a widower." Mrs. Sachs is Director of Social Service at Beth Israel Hospital in Boston. She graduated from Simmons College and received a master's degree from its School of Social Work. The bridegroom, who received B.S. and M.S. degrees from the Massachusetts Institute of Technology, is Vice President of Kalvin Miller International Inc., insurance brokers here." Thanks, Henry, and best wishes to you and Mrs. Sachs.

Milt Salzman reports he is still retired and unemployed, except on a non-compensatory basis for the Village of Lynbrook, Long Island, as Chairman of the Advisory Committee on Engineering and Public Buildings. He continues to be active singing with church and barbershop harmony groups. He expects to make another tour with the national barber shop quartet group to England, Wales, and West Germany in the spring. . . . **John P. Ramsey** writes from Greenwood, S.C., having moved last year from Seneca, S.C. His son is confined to a rest home in Greenwood with multiple sclerosis and John makes daily visits to see him and make his life more cheerful. . . . A short note from **Russell S. Grove** in Marietta, Ga., says "Still a lawyer!" . . . **Webster Garst** writes that he is working to acquaint the public with the fact that tonsillectomy has failed as a cure for the common cold, as is true of all other attempted cures to date. He feels that medical literature bears out these facts. . . . **Sam Spiker,** whose summer home has been in New Hampshire and winter home in Westport, Conn., is now a year-round resident of Dublin, N.H.

Finally, it is with deep regret that I report the death of **Irving M. (Sy) Symonds** on November 12, 1975. His wife, Virginia, informed me of his passing. My first meeting with Sy goes back to my senior year at Brockton, Mass. High School, where he was taking a graduate year to prepare for M.I.T. Both of us entered the Institute in September, 1921 and were close friends throughout our four years as undergraduates. Sy took Course III, Metallurgy, and we joined to do our thesis under the late Professor "Charlie" Locke. During the summer of 1922 we both worked at the Brockton Hospital — Sy employed as a butcher (not in the surgical area), while I was on the telephone switchboard at night. Following graduation in 1925, he went to Arizona with the Inspiration Copper Co. The great depression closed many copper mines, and Sy found himself working in Mexico for a short time. He was there long enough to decide that he loved Mexican life.

Sy met Virginia at Inspiration, Ariz., where she was teaching school. In the fall of 1934, he came back to the Institute as an Instructor in Ore Dressing. A few months later, the American Metals Co. (Ciaminera de Penole in Mexico) offered him a position in Mexico and the location was too much for him to resist. The rest of his working life was spent with that company, much of the time headquartered in Monterey. He was assigned to the New York area for a few years in the sixties. In 1968, he retired to Brownsville, Tex., and he and Virginia traveled extensively. A few years ago he moved to San Antonio, where he was residing at the time of his death. — **F. Leroy (Doc) Foster,** Secretary, 35 Woodland Way, P.O. Box 331, North Chatham, Mass.

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This is a gray day at Pigeon Cove but the clouds stand out from the overcast and with a little snow on the ground the photographic possibilities look interesting. Therefore we plan to rush out and complete the role of film on our new Olympus OMI. The balance of the film was taken of the prototype of the new Tech dinghy being test sailed off Winthrop in a 30-knot breeze — temperature 20°. The brave sailors seemed to be having a wonderful time while my shutter finger was freezing. The boat is real pretty and really flew under these conditions.

Questions about our 50th from **'Dave' Harrison,** who has attended every five-year reunion since graduation, elicited a reply from our reunion committee: The class of '26 Reunion Committee met at the Historical Collections — a place you must not miss in June. The activities will be: The Pops concert at Symphony Hall Thursday evening, June 3. Alumni day, alias Technology Day, Friday, June 4. That afternoon we go to Chatham Bars Inn, Cape Cod, till Sunday, June 6. Put this at the top of your priority. See you in June — **Don Cunningham,** Reunion Chairman.

By now you have had a formal letter from Don Cunningham and will receive another shortly. It seems fateful that so many obituaries have been coming through so close to reunion — most were regular attendees at all reunions. Even though this is the unpleasant part of being class secretary, I must tell you that the following classmates will not be with us for our 50th: **Martin Staley** of San Antonio; **Bill Edwards** of Honolulu, the longtime proponent of his perpetual calendar; **Johnnie W. Spence,** who was married to **Jack Larkin**'s sister; **George Wardner** of Wellesley, Mass., and **Howard Biggs** of Beverly, Mass. Again may I remind you there is a memorial for alumni who have died in the previous 12 months — an inspiring service if you never have attended one.

A note that **Chet Buckley** sent on his Christmas card reports on many classmates that he sees in and around Sarasota, Florida: "Dear George, your note just arrived. No, I am not a sailor. I am a veranda member of the Bird Key Yacht Club where I listen to the discussions among the "Rag Fleet" and the "Stink Pots." It is a great sport. My grandchildren took me sailing this summer in Connecticut and Seattle in their Sailfish and Sunfish.

"We had dinner with Sally and **Bill Davidson,** who live here in Sarasota. Bill and I play golf frequently. We also get together with Miriam and **Elton Staples,** Jini and **Alex Offutt** and Miriam and **Earl McMahon,** who spend the winters in this area. This summer we got together with

some of the Course VI group. **Ben Margolin** does a good job as unofficial secretary."

Finally, a note from **Ray Mancha** (the first in 50 years!) "Dear George: Having just received my 1975 M.I.T. Alumni Register, I dug out the following statistic as a possibly interesting contribution to the 'Pigeon Cove Classic!' If I can add and subtract reasonably accurately, of an original total of 822 members, our 1926 class has 540 of us still afloat, approximately two thirds. I consider this something of a record for so scurrilous a bunch of old goats! Am looking forward to seeing you and the other 539 rascals at the 50th, God be willing! Ray."

Now the sun has just come out so we should be able to do justice to the few exposures remaining in the camera but before we dash here's our cherrio until May. — **George Warren Smith,** Secretary, P.O. Box 506, Pigeon Cove, Mass. 01966

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Among all the reports of leisurely retirement, I find a few who are still occupying themselves with business, professional, or civic activities. **George Fexy,** for example, is back in action after his retirement; he's Contract Administrator for the U.S. Postal Service Construction Program in Ohio, Indiana, and Kentucky. "Quite an interesting morsel to chew on," he comments. . . . **Les Woolfenden,** since retiring from G. A. C., is busy as a bank director, President of the Lourdes Hospital Advisory Board, and president of a 490-unit rental housing complex owned by the City of Paducah, Ky. . . . **Al Buffum** is President of the Elkhart Redevelopment Committee and President of the Career Center Advisory Council, along with other civic activities. He notes, however, that he finds time for golf in Elkhart and Florida and for fishing everywhere — southwest of Anchorage for salmon, trout, and grayling; Ontario for bass, perch, and northern pike; upper Wisconsin for steelhead, sebago, and muskie. . . . **Jack Eldert,** after retiring last April as Executive Vice President of Machine Parts Corp., was rehired on a half-time basis as a consultant and continues as a Director of the company. Jack has remarried (Barbara W. Dark) and has a daughter at Lasell Junior College.

You can add your secretary's name to the list. I have relinquished the job of Director of Finance of New Rochelle, but I am still City Treasurer. We managed to have a 1976 budget adopted for the City; we negotiated a successful note sale in January in spite of the troubles of some of our neighbors in New York; and we are now working on a refinancing with long-term bonds which I hope to conclude before my retirement in August. . . . **Bud Gillies** retired at the end of 1975 as Chairman of Spectral Dynamics Corp., a highly successful manufacturer of audio, medical, and other technical equipment, of which he was one of the organizers in 1961. Bud will continue as a Director and part-time consultant, acting as an Assistant to the President.

The news is somewhat late, but last June **Bill Cave** was guest of honor at the 200th anniversary celebration of the Corps of Engineers, where he was honored as one of the outstanding retired employees of the Corps; at the same time his portrait was unveiled and placed in the Gallery of Distinguished Civilian Employees of the Corps in the Office of the Chief of Engineers. This commendation follows a career during which he received many honors and awards, including the Meritorious Civilian Service Medal, two Exceptional Civilian Service Medals, a Presidential Citation, and several Department of the Army commendations. . . . **Gordon McNeil,** on his retirement as General Manager of Military Products for Standard Products Co., also received government recognition in the form of highest letters of commendation for development work on tracks and suspensions for U.S. Army tanks. . . . **Ted Ordman** is still working full time as a patent lawyer with Kenyon, Reilly, Carr and Chapin, with whom he has been associated since 1937, and he says he has no desire to retire yet. . . . Since his retirement in July, 1974, **Milton Bearg** has kept busy with research on solar energy. . . . **Middleton Perry** is doing "a little consulting work on special electrical problems" for Black & Veatch, a consulting engineering firm with which he was associated for 38 years.

It saddens me to report that **Charlie Bartlett,** who lived at Cousins Island, Yarmouth, Me., died in December, after a brief illness. After leaving M.I.T., he first worked as a sound engineer for Western Electric Co. in Portland and then attended Peabody Law School and became a practicing lawyer. He had served as a trial justice and as a member of the Maine legislature, was also Managing Officer and Secretary-Treasurer of the Maine Savings and Loan Association for 14 years, served for 25 years as monitor of Yarmouth town meetings, and he was president of Senior Housing of Yarmouth. In addition to his wife, he leaves a son, daughter, and four grandchildren. Charlie was one of the most faithful members of the class in attending reunions, and we enjoyed the time we spent with Charlie and Ann at Winnepesaukee.

Sara Scudder also died in December. When she joined our class, she had been out of college for 15 years; she had originally come to Boston in 1923 to do research for the City under the George Robert White Fund. She had served as Senior Bacteriologist at the City Hospital on Welfare Island, New York — the first appointment to that position by the New York Department of Hospitals.

Word has been received also of the death of **Karel J. Bossart** in La Jolla, Calif. I have no details. . . . **Gordon Calderwood** writes me that **Art Connell** recently lost his wife; the sympathy of the class goes out to him. — **Joseph H. Melhado,** Secretary, 24 Rodney Rd., Scarsdale, N.Y. 10583

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Don't lose heart, now — the mini-reunions are not going out of style. In early January **Morey Klegerman** invited to lunch members of the class in the New York area. It was an excellent lunch attended by **Jim Donovan, Bill McClintic, Bob Murphy, Bill Murphy, Monte Burgess, Frank Sweeney, Ed Ure** and **Ed Walton**. Morey's purpose was to develop suggestions for the upcoming 50th and financial support to the Institute via the Class Gift.

Jim Tully writes: "Still enjoying retirement in the wilds of Maine — skiing some, traveling some, and enjoying visits from class members. The door is always open." . . . **Howard Emerson** reports that he and his wife Fanny returned last July from a trip around the world. . . . **Jim Rae** says: "Still enjoying a peaceful retirement in Sea Girt, a small town on the New Jersey coast." . . . **Nap LaCroix** writes: "1975 was rather quiet for me — little travel as limited by headaches. The big event was my wife Gertrude's half-hour private audience with H.M. the Empress of Japan, on October 5, in the Waldorf Tower Suite. We both attended the greeting to Emperor and Empress October 6 in Japan House. Gertrude was private tutor to the Empress while we were resident in Japan, 1958 to 1963." . . . **Arthur R. Smith, Jr.** retired as Vice President and Sales Manager of City Auto Stamping Co. Div., Sheller-Globe Corp. on January 1, 1971. Now he keeps busy with gardening, golf and travel. So far, he and his wife Dottie have enjoyed excellent health. . . . A report from **Chris Case**: "I retired from Veeder Root in 1971. Now I am president of a non-profit old folks home; this keeps me busy. We have about 20 women over 65. We just had a birthday party for a woman 100 years old. I am looking forward to our 50th Reunion. Last year we had the 50th for our local high school class. We had our usual three-week trip to Wells, Maine. I am still quite active in Republican politics and serve as clerk of our local Congregational Church."

A letter from **Fritz Rutherford** tells us that his wife Jo has been very ill. After three weeks in the hospital, she was home under Fritz's nursing care. A bright side for Fritz last year was his golfing achievements — he made a hole-in-one and won the handicap championship at his golf club. . . . We have also a letter from **Tony Fleming.** Tony had hoped to be at the Fiesta in Mexico but was unable to make it. His enthusiasm for the idea tells us that we can count on seeing him in Cambridge for the 50th. . . . In a brief note, **Grant Flynn** says he enjoyed talking with Jim Donovan recently. Grant, too, is hoping to be on campus in June, 1978. . . . **Dean Batchelder** wrote to tell us that his wife, Ellen, has lost most of her sight. Over a period of six months she has been to three hospitals but the cause of her trouble has not been determined. In spite of all this Ellen does enjoy their new home on a ranch at an elevation of 3,000 feet. . . . We are pleased to learn that **Gus Solomons** was awarded the Silver Beaver by the Cambridge, Mass., Council of the Boy Scouts of America in recognition "for distinguished service to boyhood." The honor was bestowed at the organization's annual scouters recognition dinner in Cambridge.

A note from **Roberta Halligan** reads: "Since the death of my husband last spring after a long illness, my lifestyle has changed considerably. I do keep active in Public Health (among other duties) as vice president of our local Board of Health, through active membership in professional public health associations and just completing a two-year term as Treasurer of the New Jersey Public Health Assoc. I also retain my interest in bowling and bridge with league bowling twice a week and 'Bridge Club' every second and fourth Thursday. Six of us have been members of the Club for over 40 years. I am looking forward to the 50th and happy that our president included us daughters in the class letter (despite the parentheses!!!)." — **Walter J. Smith,** Secretary, 37 Dix St., Winchester, Mass. 01890

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Earl H. Abbe writes, "My wife, Martha, and I enjoy our retirement years by spending summers at Lake Sunapee, N.H., and winters in Boynton Beach, Fla. We usually plan one trip each year — this year we went to Alaska — had a fine trip, but it was too hot; 94° in Fairbanks." . . . **Peter P. Gnoocheff** is enjoying his temporary retirement because of lack of work. He finds it a little difficult to live on social security and hopes to find some part-time work for supplementary income. . . . **Ted Malmstrom** and his wife Florence are on their annual trip to Hawaii and the West Coast to visit with their daughters and grandchildren. They are well and send their greetings to all their friends. . . . A note from **Neal Wells** reads, "During last summer, my wife Helen and I took a trip through Pennsylvania visiting Helen's relatives and passed through New England visiting a number of friends which included the Dinjians and the Malmstroms. We thoroughly enjoyed their hospitality. On our return trip, we shared an afternoon with **B. King Couper,** his sister and brother in law in Tryon, N.C. We talked about the fine time we had at our 40th reunion and regrets on the part of King in missing the 45th.

"We recently discovered that **Ed Gardner** and his wife Bea have settled a few blocks from where we live which gives us an opportunity to get together. On to the 50th!"

Edward D. Thomas has a hobby — visiting covered bridges and taking their pictures with historical notes, which is shared by his wife. This gives them an excuse and opportunity to travel. In his note, Ed states that Professor **Raymond F. Mosher** has retired from his teaching career at the University of Michigan and he is employed part time as a consultant. . . . **Richard T. Hoffman** has retired from government service after 42 years of service including World War II in the Pacific. "In retirement," he says, "I am busier than ever. I don't know how I managed to have time to go to the office before I retired."

Last December, **Warren Walker** was honored at the 90th anniversary of the City Club of Yonkers as Man of the Year for his contribution to the club and the city of Yonkers. The Mayor of Yonkers officiated and introduced the guest speaker, former New York State governor, Malcolm Wilson. . . . **Hunter Rouse** was the recipient of a $2,000 award from the Boston Society of Civil Engineers for a new book he has written entitled, *History of Hydraulic Engineering in the U.S.* . . . **Amasa G. Smith** is just as busy as he was before retirement three years ago and as Vice President of Chicago Bridge and Iron Co. devoting most of his time to civic affairs such as Boy Scouts, Y.M.C.A., Red Cross, Girl Scouts, and others. He also serves on boards of several companies and a bank. . . . **Edward R. Godfrey, Jr.** is enjoying his retirement. His big recent "extravaganza" was a trip by his entire family of 19 to Bermuda over Thanksgiving. — **Karnig S. Dinjian,** Secretary, 6000 N. Ocean Blvd., Apt. 14-E, Fort Lauderdale, Fla. 33308

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The following two items somehow became buried under other material; my apologies to the classmates involved for the delay. **Lou Verveer** has retired but is still living in Downers Grove, Ill. The Verveers have two children: Philip, an attorney and group leader in the Anti-trust Div., U.S. Dept. of Justice; and Mary Jane, who is married to an Air Force officer. Last fall Lou visited **Irving Dow** and saw his slides and movies of the 45th Reunion. . . . **Maurice (Yicka) Herbert** reports that he had quite a serious fire at his Franklin Paint Co. plant last April. The fire was due to arson by vandals and caused a loss of $250,000. However, the plant was able to reopen after a shut-down of about a week. As many of you know, Yicka is an avid collector of ancient coins — 270 A.D. or older. . . . **Bert Whitten** keeps busy taking care of four houses he owns in Maine, several of which are rented. The Whittens have a daughter, Jane, who is a remedial reading teacher in Milford, Mass. Their son, Bertwell, is Professor of Biological Sciences at Michigan Technological University at Houghton, Mich.

Robert Whitten is retired but does not say from what. He and his wife live in Brookfield, Vt., where he is a radio "ham." . . . **Arthur Wildes** retired as Principal of the Utica Free Academy in 1971. Arthur and his wife life in Clinton, N.Y., where his hobbies are apple growing, gardening and photography. The Wildes' daughter Nancy is married to a nuclear physicist at U.C.L.A. . . . We have a note at hand that **Bill Wye** retired from the U.S. Patent Office as of July, 1975, after 38 years of service, but no information about his retirement plans. . . . **Max Wheildon** retired from Norton Co. in June, 1973, but continued as a consultant in the field of ceramics and other high temperature materials. In addition to their home in Framingham, the Wheildons have a summer home in Boothbay, Maine, and a ski lodge in New Hampshire. Max does sports shooting and is vice president of the Southboro Rod and Gun Club. He has maintained his professional memberships and also spends much time sailing. He recently spent a month on a 142-foot schooner in Lunenberg, Nova Scotia, as a navigator and repair supervisor.

Our erstwhile president **Dick Wilson** retired in July, 1972, as Film Manufacturing Manager of Eastman Kodak Co. Dick's retirement activities include ice dancing, skiing, golfing, gardening, traveling, treasurer of the Figure Skating Club and fund raiser for the Rochester Philharmonic. Also he has primary responsibility for putting together our 50th year class gift, in which endeavor he will need plenty of help from the rest of us. In September Dick and Carol saw Doris and **Greg Smith** in Marblehead and went with them to the International Equestrian Competition at Ledyard Farms where they watched Princess Anne ride. . . . The Reverend **Vincent Thormin,** one of our two ministers, has moved west. Last September the Thormins sold their farm in Kingsbury, Quebec, and moved to Calgary, Alberta, in order to be closer to some of their children. (The Thormins have married daughters in Rossland, British Columbia, and Calgary, and a son in Edmonton, Alberta.)

We have a notice at hand that **Alvah Perkins** died on August 26, 1975. From the material in my files, it appears that he spent most of his career in government service. He retired from the Air Force as a colonel in 1960 and thereafter became a project supervisor in the V.A. Hospital Construction Program. In 1964 he built a home in Gambrills, Md., where he lived at the time of his death. Their new address is: 503-3232 Rideau Place, S.W., Calgary, Alberta, T2S1Z3. — **Gordon K. Lister,** Secretary, 530 Fifth Ave., New York, N.Y. 10036

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John Spalding retired May 1 and moved into a new home that he had built in Yarmouth Port, Mass. He keeps busy playing golf, socializing and on the town finance committee. . . . **Ed Norris** spent a most uncomfortable summer, lots of medicine and long coughing spells. Thank goodness his trouble has been correctly diagnosed and is now under control. Cutting and splitting 15 cords of wood and tending a large garden turned out not to be his prescribed treatment. . . . **Bill Jones** is keeping in great form. Recently he won his age group tennis championship in Chicago — winning the national titles for both clay and grass courts. . . . **John Hutchins** retired last June as Professor of Business History and Transportation in the Cornell Graduate School of Business and Public Administration. John has been a member of the Cornell faculty since 1940 and plans to remain in Ithaca and continue some activities at Cornell.

Now that he is retired, **Howard Huntress** spends much of his time reading, writing prose and poetry, refinishing chairs, and doing other chores. Howard says he has done his share of boating and traveling — and also reports that his four children live all over the country. . . . After many exciting years in Aero Space as a Rockets Engine Project Engineer with J.P.L. and North American, **Chauncey Hamlin, Jr.,** has retired. Chauncey is trying to get into real estate but finds it boring. . . . **George Manter** joined the ever increasing group of retirees in our class on April 1, 1975, when he retired from the New England Telephone Co. . . . **John Turner** reports that he is working like "hell" as usual as an architect-engineer on his latest "fun" project, an oceanographic laboratory for the Navy at the National Space Technological Laboratories in St. Louis. . . . Had a very pleasant chat via ham radio with **John Hollywood** recently. His call is W1SK and he has a regular schedule Tuesday morning at 9:55 on 3820 with **John Dyer,** W1BJD, and **Cliff Harvey,** W1RF, as well as some other M.I.T. hams from other classes.

Kenneth Jamieson has been elected life member of the M.I.T. Corporation and our Class President, **Howard Richardson,** begins a one-year term as an ex-officio member of the Corporation following his tenure as the 1975-76 President of the M.I.T. Alumni Association. . . . A newsy and interesting Christmas letter from the **John Swantons** brought me up to date on their family during 1975. John and Louise supervised the arrival of a tenth grandchild and son Ken's graduation from Harvard Business School. John has been too busy to work, and Louise has nearly finished the Swanton Genealogy.

On December 15, 1975, your 45th Reunion Committee met at Jan and **Larry Barnards** and the following basic committees consist of: General Chairman, Jan and **Larry Barnard;** Deputy Chairman, Laura and **Fred Damiano**; Publicity Chairman, Polly and **Ken Germeshausen**; Program General Chairman, Sally and **Art Newell**; Special Guests Chairman, Evelyn and

Howie Richardson; and Reunion Treasurer, **Claude Machen.** The following reunion program has evolved: *Tuesday, June 1*: Reception committee aided by an Alumni Office Secretary to greet members as they arrive. Space reserved at the Stratton Student Center for dinner, with an informal get-together before and afterward in the dormitory, with a bar, hopefully including a supply of that dark brew which **Russ Pierce** made a class reunion tradition.

Wednesday, June 2: Breakfast each morning at the student center. Day is open for tours in or outside Boston, golf, tennis, swimming, sailing, etc. Class dinner in the evening with Ruby Newman's orchestra.

Thursday, June 3: Two-hour program at M.I.T. Historical Collections followed by a light lunch. In the afternoon: cocktails at McCormick House, dinner on the waterfront at the New Union Oyster House, then on to Symphony Hall for Pops.

Friday, June 4: Alumni Day, now called Technology Day, with a full program. So far, 134 of our classmates and their wives have said they planned to attend the Reunion. — **Edwin S. Worden,** Secretary, 35 Minute Man Hill, Westport, Conn. 06880; **Ben W. Steverman,** Asst. Secretary, 260 Morrison Dr., Pittsburgh, Penn. 15216; **John R. Swanton,** Asst. Secretary, 27 George St., Newton, Mass. 02158

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Our perfect host and hostess of the 40th Reunion, Susanne and **Juan Serrallach,** both report excellent health. They were off to Vienna, Austria for a short holiday. They are most enthusiastic about another reunion in Spain. Juan's note reads like a Madison Avenue travel ad in parts, especially the places to go and the things to see. This past summer they had a delightful vacation in the Pyrenees, picking blueberries and strawberries, playing golf and fishing for trout, even crossing the border for some French movies, and spending nights "in the wilderness enjoying the peace and freedom of hearing neither radio nor television."

Norma and **Minot R. Bridgham** both experienced back troubles which dampened their plans last year. Minot's laid him low for short spells from June to September, while Norma's, treated initially in April, wasn't resolved until November. Nevertheless they report, "We're both enjoying life, keeping busy and looking forward to 1976 to renew in good health the activities we missed this year." They had hoped to get to Bermuda, but had to settle for a week at Eddy Farm in Delaware. They did manage to get a little golf in sporadically at West Point, and Minot additionally with the Old Guard at Banksville. Norma gave time to an Extended Care Facility while Minot extended the project he had worked on at the N.Y. Medical College in Grasslands in '73 and '74, and assisted in installation of a computer at the Westchester Division of the N.Y. Hospital. Minot also helped his son Dick to build a garage to replace one that had mysteriously burned. Minot is active in church as a choir member and assistant treasurer and chairs the Finance Committee of the Board of Directors of the White Plains Y.M.C.A.

George B. Hoadley recently took his wife on an A.F.A. trip to New Zealand and Australia, stopping in Fiji and Maui on the way home. "It was just great," according to George. . . . **Edward V. Powell,** retired and skiing daily at Stowe, Vt., furnishes a brief resume in a recent report: "I am grateful to M.I.T. for keeping me on the record as the Class of '32. Upon graduation from Tufts at the onset of the depression, I undertook to catch up with the mainstream of scientific developments. Circumstances found me in New York City with a career in music, radio, recording, television — meanwhile carrying on my private research which led to eight U.S. patents including invention of the ORKON — an educational musical instrument. During the Sputnik 'crunch' I taught college mathematics and physics."

Lee T. Tyburski's son Thomas is a Navy flyer stationed in Adak, Alaska, and his daughter, Thea, is married and living in Hawaii where she is a stewardess for Pan Am. Lee still spends summers in the Pocono Mountains. He may be pulling my leg by telling that he is letting his wife do all the traveling, recently to Australia and New Zealand. . . . **Robert E. Moore** retired from Western Electric Co. after 34 years. He was assistant manager of development and manufacturing engineering. Bob mentions meeting Jim Fisk, '31, at one of his last business conferences. They were both Kappa Epsilons. His only son is now a director and producer at ABC-TV. . . . **Bob Follansbee** is retired and lives in South Portland, Maine, spending summers at the old homestead in Guildhall, Vt. . . . **Alwin B. Newton** consults in solar heating and cooling of buildings, and has been overseas twice since August, and to many locations in the U.S. Alwin has just managed the technical review of E.R.D.A.'s P.O.A., and will be in Australia in 1976 on solar programs. His wife says, "What retirement?"

The Alumni Records Office reports the passing of **Francis A. Carboine** on May 13, 1975. We extend our sincere sympathy to his family. — **John W. Flatley,** Secretary, Apt. #204, 5100 Dorset Ave., Chevy Chase, Md. 20015

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Most emphatically, top billing this time around is for **John Wiley,** erstwhile bachelor, and now, praise be, a benedict. Since November 15, John has been married to Johanna N. Van Der Veen, widow of the late former Director of the Schiphol Airport in Amsterdam, The Netherlands. Johnny and his bride now live in Harbor Towers, India St., Boston. Well, I can't say that this move was expected, but I am plenty sure that the Class of 1933 offers their best wishes.

A fine note from **Courtenay Marshall,** Vice President, who says that he cannot make the Fiesta because they have long since arranged for a Far East cruise. The Marshalls are owners of a 50-acre pecan orchard of 1,600 trees. It seems that Court planted this large capital outlay without knowing that he had erected a substantial tax shelter, because it appears that he is operating a research project.

Now for the Christmas messages, which you will read four months late: cards arrived from Clare and **Bill Baur,** Katherine and **Carl Swanson,** Fran and **Colonel Newton,** Cele and **Harry Summer, Westy Westaway,** Charalee and **Dick Fosset** and Bess and **Slick Henderson.** Bess writes that Slick travels to Fulton, Mo., twice a week, assisting in administration at Westminster College, Slick's first school, where he is for three years Chairman of the Board of Trustees, and which school has quite recently awarded him the honorary degree of Doctor of Science. Another card, from Barb, **Ken,** Patty, and Penny. I sure muffed this one, so must guess that it's from the **Moslanders.**

Now comes a series of family Christmas letters: top one is from Lucy and **George Henning,** always a large page story of their home and travels; this year a montage of many photos, with a short treatise on each. . . . Doris and **Len Julian** write that they've not done too much traveling, which is understandable, because they both are so busy right around home — Len with his various artistic projects and Doris with her needlework. They did make a short trip to Bermuda, earlier, to attend a duplicate bridge tournament. . . . Bobbie and **Bill Harper** came through with a rather long message on their card, in which Bill says that Mexico is out because of too many previous commitments. . . . A nice card and long letter from Marcia and **Red Payne,** well settled in their new retirement home in Canandaigua, N.Y. They spent six months in Europe last year, starting in November by picking up a Volkswagen and touring England, thence to Rennes, across France to the Spanish border, then all along the Spanish Coast to Portugal for Christmas in Lisbon. After that, two months in a village south of Lisbon, then Spain, North Africa, a ferry to Italy, and finally Luxembourg, where they turned the VW over to a shipper. Red had himself a hernia repair job when he got home.

A card from Jeanette, Heidi, and **Werner Bachli,** who announce that they are well settled in their new retirement home in Lenox, Mass.; Werner was leader of the Appalachian Mountain Club August Camp for two weeks. They all do a lot of outdoor pleasures: hiking, picnicking, camping, and skiing. . . . Prue and **Horace MacKechnie** came through with a fine family letter about, first, a Defense-Department-sponsored trip to Ireland, where they visited just about all over. Later Horace had a bad set-back when he discovered that he had angina, gall bladder, and some coronary trouble. The heart trouble showed up when the surgeon was about to work over the gall bladder, and Horace ended up in intensive care. It is not too clear how, but Horace is now back at work after a lengthy convalescence.

Jermain and **Jack Andrews** come through with their usual fine Christmas letter about the family year. No long trips this time, but, added up, it is impressive: Thanksgiving at the Greenbriar, February cross-country skiing in Vermont, Williamsburg for their wedding anniversary, July for vacation at Blackstone Lake, then back to Vermont in the fall for the foliage time. Jack adds a footnote: "Still working on what might later be the Central New Jersey M.I.T. Club, perhaps at Princeton." . . . We have a short one from **Bill Baur,** who has been, recently, made Secretary-Treasurer of the M.I.T. Club of Central Florida.

As a finale, Leona suggests that I send blanket thanks for all the lovely cards and family letters received at Christmas time. We, for once, had plenty of material, a situation which depends wholly on our readers. I might suggest that our fine class wives take a hand, and do some writing to ye scribe. — **Warren Henderson,** Secretary, 1079 Hillsboro Beach, Pompano Beach, Fla. 33062

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A news clipping describes **William A. Baker** as the designer of the *Mayflower II* at the Plymouth Plantation. The article places him as a naval architect with Bethlehem Steel. I know he's a lecturer at the Institute and has been curator of the Francis Hart Nautical Museum for some years. . . . **Arthur O. Williams, Jr.** has been a member of the Brown faculty since 1942 and has now been appointed the Hazard Professorship. He is only the fourth Brown faculty member to occupy this chair since it was established in 1869.

I am sorry that I have one more loss to report — that of **Emerson P. Hempstead** on December 3, 1975. He had served as a commander in the Navy during the war and at the time of his death he was retired as Vice President of the Fireman's Mutual Insurance Co. He is survived by his wife, Frances, and a brother, William. To both we offer our sincere sympathy.

The fund notes continue to run the gamut from cryptic through far-out to chatty. **Walt Wrigley** simply says, "Early retirement on October 1, 1975 as Professor Emeritus." He and Dorothy should be able to pick their own times to go traveling now. . . . From **Tom Apjohn:** "Retired after 38 years with Mobil Oil Corp. Still active in a consulting capacity." . . . I get the feeling that **Harry E. Heiligenthal** is less than fully happy with the state of affairs when he writes, "Society today is all sail and no rudder! quoth the *old retired* M.I.T. man!" I think I'd agree if I knew which particular areas were causing the worst heartburn.

A little more specific from **William Schumacher:** "With Mary's graduation from Dickinson, the kids collectively have six degrees, including Paul's M.S. from M.I.T. (just in time to find the world not paying much attention to degrees just now). After a rather rough winter, I hung on for a while but finally retired June 30." . . . **Ed Geittmann** writes, "Mary and I still enjoy memories of the reunion in 1974. Having only one son left in college, we have done a bit of traveling: Russia last Christmas and New Years — everything you read about is true. Portugal just before the uprising. Now Yucatan and Guatemala next February. See y'all in 1979."

I will wind up with comments from two that are still in harness. **Tom LaCava** says, "Still with the New Hampshire Water Supply and Pollution Control Commission; family of five youngsters all on their own; just Bea and I continue at the old homestead in Suncoob, N.H." Finally, **Irving Kusinitz** is still globe-trotting as he writes, "I'm still operating and doing some traveling as Director of Engineering for Beatrice Chemical. In June, 1975, I took my wife, Rose, on a business trip to Europe where we spent a couple of weeks in Holland, Belgium, and Spain. On December 22 I returned from a week each in Mexico City and Rio de Janeiro. In between foreign trips I do my U.S. traveling and try to catch up on all the engineering demands of a worldwide miscellaneous chemical operation of 19 plants. Son Ralph and his wife Carol just contributed a grandson in August. Joshua and his sister Felicity are our two grandchildren." I must say, if I had a job that took me around like that, I'd stay with it too.

So much for now — if you were good enough to send some words and don't see them there — watch for next month. — **Robert M. Franklin,** Secretary, Satucket Rd., Brewster, Mass. 02631; **George M. Bull,** Assistant Secretary, 4961 Allan Rd., Washington, D.C. 20016

35

Plan to be in Cambridge on Technology Day 1976, Friday, June 4, and stay for a dutch-treat dinner and a social evening with other '35ers and their wives at the Faculty Club. With a little luck and cooperation we will have movies and slides from last June. It is important that you let us know so we can be sure to have sufficient space; write or telephone me (617) 244-9032 (we have a Phone-Mate we turn on when we are out, so leave a message).

Art Haskins writes from Bath, Maine: "Just received 20-year service pin from Bath Iron Works. Worked ten years for B.I.W. before going on my own for ten years. Too busy this summer to get in much sailing but hope to make up for it next summer." . . . **Sam Brown** sent a note via the Alumni Fund, "Early December golf at Dorado Beach, Puerto Rico, was flooded out. On to La Jolla and Torrey Pines in late January, then Naples, Fla., for first half of March. Semi-retirement is *great*!" . . . **Bob (Robert P.) Landis** retired from the Pratt & Whitney Aircraft Division of United Technologies on February 28 after more than 35 years with the East Hartford activity. Since that time he and Rita have moved to a smaller apartment in Manchester, Conn., but most of the year were at their little home along the St. Lawrence River near Ogdensburg, N.Y.

Kenneth M. Warren is another to retire. He left Allendale Mutual Insurance Co. on January 1, 1974, and is keeping active with time divided between home in Warner, N.H., and Cranston, R.I. . . . **Joseph Oldham** is torn between "retirement pains" and the enjoyment of retirement activities in Central Falls, R.I.

Hopefully by now you have received the new Class of 1935 Directory. Those of us who are still getting around the country either for business or pleasure should always carry this little booklet with us. I enjoy making phone calls to former classmates living in the city where I may be staying the night on a business trip. That's where some of the information develops that appears in these notes. If any of you do this, please let me know just so that I can mention it. And please remember our Class get-together June 4, and *let me know that you are coming*. — **Allan Q. Mowatt,** Secretary, 61 Beaumont Ave., Newtonville, Mass. 02160

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As **Alice Kimball** said last time, she is off on a ten-week trip to New Zealand and Australia. Expects to return home in late April. Meanwhile, I am handling the Class Notes and look forward to any news sent to me at the address at the end of this column.

First of all let me remind you again of the Reunion June 3-4 in Cambridge and June 4-6 at Jug End, South Egremont, Mass. You should have received notices about this in the mail. Please reply if you haven't; the committee — **Henry McGrath, Alice Kimball, Fletch Thornton, Dana Devereux, Charlie Saffer, Frank Philips, Harold Miller** and **Tony Hittl** — we look forward to a large turnout of classmates and spouses.

Now for the news items. After 23 years of industrial problem-solving in the statistics and probability area, **Dorian Shainin** has retired from Rath & Strong. He is now working independently around the country and abroad and reports that he is busier than ever. . . . Another retiree is **Bill Kennedy,** who has left Lockheed Aircraft where he was involved in economic analysis and commercial transport market planning. He is now planning to go into consulting work. . . . **Hugh McMath** has recently retired from the University of Texas as Professor Emeritus of Architecture. During his years of teaching, he developed a deep interest in the pre-Hispanic and Colonial Architecture of Mexico, organized tours for students and faculty to visit the cultural sites, and organized an architecture workshop at Monterrey, Mexico, for American students. Upon retirement his students from the past 44 years gave him a trip to the Mayan sites in Guatemala and Honduras. Because of Hugh's efforts in developing cultural relations between the United States and Mexico, he was made a Fellow of the Royal Society of Arts of Great Britain.

Since his retirement in 1974, **Al Dasburg** has built a passive solar-heated house on one of the original routes of the Santa Fe Trail in the hills outside of the city. He reports that it is working well in temperatures that range from −20° to +90°F. . . . **Ed Halfmann** is still at work after 11 years as Director of Research of the Philadelphia Electric Co. . . . **Al Del Favero** has completed 19 years as Chief Engineer and most recently as Manager of Real Estate for Oman Construction and is still on the job. He has three grown children who are graduates of Tulane, Notre Dame, and the University of Tennessee. . . . **Gerry McMahon** is still head of Cities Service Laboratories in Lake Charles. His youngest daughter received her B.S. in mathematics from the University of Southwestern Louisiana, and his son is a sophomore at the same school.

If you happen to be in the cockpit of an airplane approaching Allentown-Bethlehem-Easton Airport, you might well hear the controller instruct the pilot "Report Wiley inbound." One of the run-ways has been named for **Wilfred "Wiley" Post,** who is manager of the airport. . . . **Laddie Reday** spent August in England and then went on to Australia and Tasmania. His home base is Newport Beach, Calif., where he owns Western Water and Appliance Co. He has drifted into writing and is interested in a yearbook to celebrate our 40th Reunion. Would someone like to help him on this project? Let me know.

Henry Lippitt has also been traveling, as usual; in 1975 he spent May in the Indian Country of Arizona and mid-summer in the White Mountains of New England. He is still Executive Secretary of California Gas Producers Association. — **Anton E. Hittl,** President, 158 Manville Rd., Pleasantville, N.Y.

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Wells Coleman has retired from the Gleason Works as a research staff engineer. He expects to do some additional consulting work in the future in the field of gear design, especially in bevel and hypoid

gears. In addition, he has spent much time in writing technical literature including society papers (A.S.M.E., A.S.L.E., A.G.M.A., Institution of Mechanical Engineers), magazine articles and company technical literature. . . . **Ed Fischer** and his wife Emily are on a two month trip to the far Pacific where they will visit their son (M.I.T., M.B.A. '67) and his family in Singapore.

Bernard Schondorff, former President of Hegenscheidt Corp., Erkelenz, West Germany, and Hegenscheidt Corp. of Detroit, Michigan, is now Chairman of the Board. Hegenscheidt is a well known machine tool builder. Bernard studied in Dresden, Breslau and Berlin before he came to the Institute. . . . Marion and **Joe Heal** have been to Germany, Switzerland and the Canary Islands in the past year. Joe is definitely planning to retire in June, '77 when he will be celebrating at our 40th Reunion. . . . Jean and **Bob Rudy** are grandparents once again as their son, John (M.I.T. '67) and his wife had a baby girl, Hilary Beth. Their other grandchild, Brett, is now three years old. . . . Martha and **Joe Smedile** are still in Wilmette, Ill. Martha has continued to make progress during the past year from her incapacitating illness, and they have recently traveled to Portugal and Spain. Joe is with the Northeastern Illinois Planning Commission. . . . Elvie and **Norm Birch** are continuing conversion of their summer cottage to a year-round home at So. Carver, Mass. During the last summer their son Eric and his family purchased the cottage next door before they departed for a two- to four-year stay. Eric is heading a subsidiary of Corning Glass there. Their other son Alan and his wife Kathy are in Louisville, Ky.

Our sympathy to **Lou Bloom,** whose wife, Grace, died November 20, 1975. Lou is still with General Electric. — **Robert H. Thorson,** Secretary, 506 Riverside Ave., Medford, Mass. 02155; **Lester Klashman,** Assistant Secretary, 198 Maple St., Malden, Mass. 02148

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Rose E. Lunn's work record was confused with someone else's, and the following is correct: Head of Vibration and Flutter Group, Curtiss-Wright, Buffalo, 1941-42 after studying at M.I.T. 1937-41; Group Leader, Vibration, Flutter, and Acoustics, North American Aviation, Los Angeles, 1942-63.

Clark S. Robinson has been appointed Editor of the *Soviet Journal of Nuclear Physics,* a translation journal published by the American Institute of Physics. . . . **Russell C. Coile** is now back in Bethesda, Md., after a year in Italy and three years in England. He has been doing operations research for the U.S. Navy for 28 years. . . . **Scott Calvin Lyon** is currently employed as International Economist with the Treasury Department's Office of East-West Economic Policy. Scott's work is concerned with U.S. trade with communist countries. . . . **John R. Summerfield** is now heading Summerfield Associates, a research and consulting firm specializing in aviation and tourism, with headquarters in Santa Monica, Calif. . . . A newspaper item announced the promotion of **Tony Chemel** to Senior Vice President of Armbrust Chain Co. in Rhode Island; Armbrust is one of the world's largest manufacturers of decorative chain used in the jewelry and handbag industries.

Bill Kashdan's son reported that he passed away late last summer. — **A. L. Bruneau, Jr.,** Secretary, Hurdman and Cranstoun, 140 Broadway, New York, N.Y.

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John Renshaw started the New Year in unique style. On January 3, John was married, left his home near San Francisco, and started a ten-day honeymoon in sunny Bora Bora, near Tahiti in the Polynesian Islands. Upon return to the Bay area, John will continue his investment counseling and defense work. . . . Congratulations are in order for a second pair of newlyweds. Edna and **Al Laker** sent a Christmas card which showed these honeymooners in Hawaii. They will make their home in Glendale, Calif. . . . **Bill Chance** has been active in Alaska on the pipeline project. He manages every now and then to come back to the lower 48 to visit the homestead which is in Portland, Oregon. . . . Marge and **Phil Bush** make their lovely home in a 25-acre canyon near Orinda, Calif. Phil commutes a few miles each day to the Mahogany Halls of Kaiser Engineers in Oakland, where he deals with nuclear and engineering projects, and some which are just ordinary engineering — construction things, such as building new support facilities for interspace projects. Ten years ago Phil demonstrated forward planning by engineering and installing an effective solar heating system in his swimming pool. . . . Bets and **Burt Klienhofer** have retired and established new residence at Naples, Calif. As a radio ham for many years, Burt made many contacts with people in Australia, New Zealand, Tahiti, Mexico, the Far East, and Europe. Later Burt and Bets visited all their radio friends. Nowadays they pilot and navigate a Skyhawk airplane and cruise in their motor launch around their marina-located home. Burt says this is a far cry from the old days in Philadelphia, and that is probably an understatement.

Bud Croshere retired after 33 years with McDonnell Douglas and continues to make his home at Santa Monica, Calif. His hobbies include orchid growing, sailing, building ship models, and not commuting 66 miles per day. . . . **Orv Dunn** continues at McDonnell Douglas where he is Chief of Aerodynamics. . . . **Norm Capen** retired after 33 years with I.T.T. His hobbies include swimming, wood-working, and maintaining his property. . . . **Woody Baldwin** lives at Long Beach, Calif. At Aerospace Corp. he consults and advises about sophisticated problems connected with space efforts. He races sailboats and is president of the local fleet, he plays both flute and oboe in small ensembles, and has continued his fencing all through the years. Woody reports his weight today is only four pounds more than it was during undergraduate years. Those of us who struggle with increasing girth and wrinkles will have to give Woody a special achievement award. . . . **Hank Landwehr** has enjoyed the Long Beach, Calif., area for the last ten years and is working with a chemical testing laboratory. . . . **Paul Sandorff** is with Lockheed and works on structures research. Skiing is one of Paul's hobbies and the ski slopes are conveniently nearby.

Nick Ferreira is now retired, but up to a year or so ago Nick was Town Engineer for Sasolburg, South Africa. . . . **Ben De Simone** now lives in Medford, Mass. From this base he operates the Medford Construction Co., a ski lodge in New Hampshire, and a restaurant in Santa Monica. . . . **Morgan-Sze** is Vice President, Research and Development of C-E Lummus. His full-page color photo can be seen on page 60 of the December 29 edition of *Business Week Magazine*. . . . **Ruth Pitt** has raised her son and daughter and now makes her home in La Jolla, Calif. During the last five years Ruth has taught high school and she is about to start a course at the University of California in San Diego. — **Hal Seykota,** Secretary, 2561 Via Viesta, La Jolla, Calif.

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Honors: **I. M. Pei,** architect and member of the M.I.T. Corporation, has been elected to the American Academy of Arts and Letters and will be inducted at the annual ceremonial of the Academy-Institute in May. This honor is on the heels of the 1975 Harleston Parker Medal, awarded to the firm of I. M. Pei and Partners of New York by the Boston Society of Architects. Cited was the firm's work on the Christian Science Church building and park development along Massachusetts and Huntington Avenues in Boston.

Alumni Fund Spin-off: My receipt from the Fund includes a note from fund-drive chairman, **N. Bruce Duffett,** of Erie, Penn., who lays claim to healthy living — tennis and cross-country skiing — while still active in the plastics game with Plastics Engineering Co. He reports a recent pleasant evening with **George Kaneb** in Cornwall, Ontario, Canada, who among other achievements is now a tournament player, curling with broom and stone.

On the Backs of Alumni Fund Envelopes: **William E. Hammond,** is running a consulting service, Walter E. Hammond Associates, in Unionville, Conn. . . . **S. A. Kaufman,** professor in the urban planning department of California State Polytechnic University, in Pomona, is also involved in community conservation and planning. . . . **George R. Weinbrenner,** retired, colonel, U.S. Air Force, settled in San Antonio, Tex., but is spending several months each year in France, (where in France, George?). . . . **Charles M. Edwards,** moved from Pasadena, Calif., to Grand Junction, Colo., with Bendix Field Engineering Corp., to work on the National Uranium Resources Evaluation program. . . . **Joseph L. Mahoney,** of Ventura County, Calif., is with the county's public works agency, working on their roads. . . . **Robert A. Deshon,** academician by trade in Cincinnati, Ohio, spent last summer photographing all the county courthouses of Indiana. He's done it before, but in Ohio.

Bell Labs. Reports that **Stewart E. Miller,** living in Locust, N.J., has completed his 35th year with Bell, and is now director of the Guided Wave Research Lab at Crawford Hill. He shared the 1975 W.R.G. Baker Prize Paper Award of the I.E.E.E. with two other lab scientists.

In Memory: **A. Gordon Hull** died on November 28, 1975. He was Vice President for Engineering of Prudential Lines, Inc., last residing in Jamestown, R.I. . . . **Joseph R. Burns,** on October 15, 1975; most recently manager of engineering and market-

ing systems at the West Lynn plant of General Electric Co., last residing in Swampscott, Mass.

Are You Out There? Using a table of random units, I have selected names from our computer list of 1940 graduates. All of the readers want to hear from you and about yours. The *Random Roll Call* for this month: **Alan M. Thewlis,** San Diego, Calif.; **Daniel W. Puffer,** Melrose, Mass.; **Fred P. Lobban,** Yarmouthport, Mass.; **Jerry L. Schwartzberg,** Woodmere, N.Y.; **Richard W. Cobean,** Libertyville, Ill.; **Robert T. Dorsey,** Cleveland, Ohio; **Helen A. Brown,** Boston, Mass.; **Amos E. Joel, Jr.,** South Orange, N.J.; **John R. Kane,** Newport News, Va.; **(Mrs.) George J. Dienes,** Stonybrook, N.Y. — **Frank A. Yett,** Secretary, 1405 Ptarmigan Dr., Walnut Creek, Calif. 94595

41

It's only January and I received my deadline notice for the March/April *Technology Review* class notes. There was a sketch of a bunny with the notation "Hop To It!" This reminded me that June is not that far away and it's the 35th Anniversary of our graduation. The reunion dates are June 3 to 6. Being the bicentennial year, Boston's celebration will play a significant role in our reunion. **Leona Zarsky,** Reunion Chairperson, sent all of us a letter on December 26. If you didn't receive one or want to make a reservation, write **Frederic W. Watriss,** Treasurer, Class of '41, M.I.T., Room 4-110, Cambridge, Mass. 02139. In any case mark the date on your calendar now!

Our Classmate **Robert Sinsheimer,** Chairman of Cal Tech's Division of Biology, was quoted in the *New York Times* in a debate on genetic engineering as saying, "We must finally recognize that to re-shape man is not a beguiling laboratory experiment but an expertise that involves the ultimate in value judgment." From another publication, "The world-renowned geneticist and professor of biophysics pointed out that the age of genetic engineering is here at the level of the microbe. He suggested that the extension of such techniques to higher organisms may be within the reach of human ingenuity."

Here's a rundown of news we've received from our classmates: **David L. Shapiro** is President of Betadyne Corp., export distributor of laboratory instruments. . . . **I. Harry Mandil** is the principal officer of M.P.R. Associates, Inc., Washington, D.C. . . . **Robert E. Smith** was elected a Fellow of American Consulting Engineers Council. . . . **Lyle Richardson** informs us that, "After fifteen years as Senior Vice President of Horton Church and Goff, Inc., a major New England advertising agency in Providence, R.I., I left last year to enter the publications business. I am currently Associate Publisher and North Country Editor of a new monthly magazine, *New England Outdoors,* which I helped start in February, 1975." . . . **Sam Fry** is at it again. I previously reported he has climbed the 19,000-ft. Mt. Kilimanjaro and now he writes, "Last Fall I visited my first grandchild in Tübingen and, while in the vicinity, fulfilled a long-time ambition to climb the Matterhorn. Have just finished a two-year term as President of The Mountaineers, based in the Seattle area where I am still working for Boeing." I'm not certain he's a Classmate of "ours!" . . . **W. L. Fader** retired as Vice President of Operations for United States Steel's Eastern Division. . . . **E. Kirkbride Miller** was elected Chairman of the Board of T. Rowe Price Associates, Inc. The firm manages total assets in excess of $5 billion.

The Class of '41 is coming — to its 35th Reunion. Hop to it. . . . See you there! — **Henry Avery,** Secretary, U.S.S. Chemicals, 2863 — 600 Grant St., Pittsburgh, Penn.

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Mike Frueh brings us up-to-date on his family: "Off with Toni (my wife) to spend a sabbatical semester in the Chemistry Department of University College, University of London. Son Jonathan a senior in E.E. at M.I.T. Son Timothy a free-lance stage designer in Boston. Daughter Carol has provided us with a grandson." . . . **John Lacy**'s youngest son Roger is a freshman at Tech making three generations of M.I.T. for the Lacy family. . . . Betty and **Dick Haven** became grandparents in October, 1974! Guess they do not consider this "hot" news. . . . **Don Kern** is currently Vice President of Specialized Systems, Inc., in Mystic, Conn. The firm specializes in engineering of general marine equipment including underseas vehicles.

Chris Peek sends bouquets to *Technology Review* on its December issue, devoted to recent developments in cosmology. . . . **Jack Quinn** is still keeping very busy with his multifarious regatta and other sailing activities up and down the California coast.

Jean and I just got back from a delightful three-week vacation in India with Francine and **Jim Stern.** Started at Bombay, went to Baroda, Aurangabad, Jaipur, the Sariska Game Sanctuary, the Bharatpur Bird Sanctuary, Fatiphur-Singri, Agra, Khajuraho, Varanesi, and Delhi. The January weather was superb and although we only saw the northwestern corner of this huge country, the trip was great.

I took about 700 color slides and around 300 color negatives for prints — all are available to anyone coming this way. We spent a delightful few days with Savita and **Nanu Amin** in Baroda and at their Vatabra Farm. Nanu's Jyoti, Ltd. continues to grow with extensive new electrification in India. He just finished a beautiful five story research and development building; has about 200 people in his research and development operation working on everything from small motors and generators, switch gear, huge generators and turbine pumps to an interesting project in solar energy.

Savita and Nanu's Vatabra Farm is a showplace of scientific agriculture, using a minimum of sophisticated equipment and designed for the average small Indian layout. They grow cotton, sugarcane, tobacco, millet and other grains, vegetables, and have 1,000 lime trees. Ended our trip with five days in Delhi, including a cocktail party and dinner with members of the M.I.T. Club.

The food and hotels were first rate, and the Indian hospitality was superb. This country, with its ancient Hindu, Muslim and Buddhist traditions and centuries-old culture, should not be missed.

Two more retirees: **Frank Bellaire** from Millersville State College and **John Fellows** from his position as Consulting Editor with the American Society for Metals. We wish them both good health and happiness in their new status.

Just received notice of the death of **Elliott Friedman,** who graduated with us in Course VI. He lived in Plainview, N.Y., and we extend sincere condolences to his family. — **L. K. Rosett,** Secretary, 191 Albemarle Rd., White Plains, N.Y. 10605

43

If you are disappointed in not having seen any class news in the December and January issues, so am I, as I am utterly confused with when and how these ever get published. My lead time is about eight weeks, and my issues arrive six weeks late, so who knows? But I'm trying, guys, really I am. And so, on Valentine's Day, I write again. Last November **Hamilton Herman** was sworn in as Assistant Secretary of Transportation for Systems Development and Technology of the United States Department of Transportation. An industrial consultant, he was formerly a senior vice president for development of the American Can Co. In the early fifties he was assistant to the president at M.I.T., and prior to that was manager of the Institute's Instrumentation Laboratory Flight Facility. Herman lived in New Canaan, Conn., before his Washington move, and he and Martha have a daughter, Carolyn.

Richard Zeamer wrote that last fall he received his Ph.D. in mechanical engineering from the University of Utah. He is currently senior technical specialist at the solid propellant rocket plant of Hercules, Inc., at Magna, Utah. His technical interests are in fluid mechanics, two-phase flow, combustion and acoustics. In rocketry he is considered expert in thermochemistry, flow analysis, nozzle design for maximum thrust and performance prediction. . . . Charles Estes, '42, who got his master's with our class as a VI-A electrical, wrote that he recently received his 25-year pin from Motorola, where he is currently acting director of their corporate research laboratory. Charlie wrote that after his wife's death in 1972 he met a charming English girl and is happily re-married. . . . **Bill Holway** of Tulsa sent us a little note of his present doings. He is Executive Vice President of Benham, Blair & Affiliates, Inc. (of Oklahoma City) and President of its Tulsa branch, W. R. Holway and Associates, Inc., which many of you know as one of the oldest and finest consulting engineering firms in the west, founded by Bill's dad, Class of 1915. Bill is a past president of the American Consulting Engineers Council, and is active on the board of the Unitarian Universalist Association as national finance chairman.

Former apprentice class secretary **Jack Kelly** wrote that he is still kept plenty busy running the worldwide business of Butterworth Systems, Inc., the world's leading supplier of specialized tank cleaning machines for marine and shore industries. Kelly wrote, and I quote, "Take your beer for example." (At this point I took a beer.) . . . "Did you know that Butterworth machines are used by essentially all the leading breweries of the U.S.A. to clean cookers, fermenters and other parts of their production line? This remarkable cleaning machine saves hundreds of 'little men' from having to climb inside tanks, vats, etc., so they tell us. On the other side of the business, Butterworth machines are used in the new half-

million deadweight ton tankers." I wish we knew about these machines back in the early fifties, when **Kemp Maples** was making home brew in big crocks, because then Kemp wouldn't have had to climb inside those crocks to clean them, which wasn't easy, as he is not a "little man."

John Ward is serving on the Cable Television Advisory Committee in Lexington, Mass. . . . Vice Admiral (Ret.) **Robert L. Townsend,** U.S.N., who received his master's with our class in aeronautical, is Chairman of the Board of Grumman International, Inc., where I am sure he runs into **Corwin Henry Meyer** and **"P. A." Anbro** who are career men at Grumman. . . . **Marjorie K. Smith** is still active in public health clinics, and is teaching in the P.N.A. program for Cornell Medical School. . . . Mary McJunkin, widow of classmate **Howard McJunkin,** who passed away last year, wrote a beautiful letter, bringing us up to date on her four sons: the oldest an engineer with the family business, McJunkin Corp. in Charlestown, W.V.; second son a doctor in his second year of residency at University of Virginia; third one a lawyer in Washington, D.C.; and number four in his third year at medical school. Wow! Mary sent a very generous gift in Howard's memory for the Alumni Fund. . . . All of you are getting good looks at **Oivind Lorentzen**'s picture in your local newspapers, as part of his Flagship Cruises advertising for his vessel, the Kungsholm. Their six cruises to the West Indies this spring sound tempting. This is the motor ship that I mentioned last year as a possibility for our 35th reunion. I hope that Jack Kelley can sell cleaning equipment to Oivind's company, to clean out their beer tanks, etc. — **Richard M. Feingold,** Secretary, 115 So. Main St., West Hartford, Conn. 06107

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I missed the last issue as I was on another 'round-the-world business trip, with stops in Japan, India, Iran, and Israel. Most interesting!

I know the column is read, because my plea for volunteers for Class Secretary brought forth great results. **Newton A. Teixeira,** 92 Webster Park, West Newton, Mass., 02165, has volunteered through his wife, Melissa. Most of us knew her as **Melissa Wood** during our undergraduate days. So starting with the next issue, you'll have new style. Let's keep Newton and Melissa loaded with news.

John Woolston writes, "I retired from the U.S.N. as Captain September 1, 1974, from the billet of first deputy commander for shipbuilding of the newly-formed Naval Sea Systems Command. I had come to Washington from a seven year tour in the Charleston Naval Shipyard — the last three as Commander. Now Laura and I are living in Teheran, Iran, and working for Stanwick International, Inc., where we are Administrative Assistant and Engineering and Management Adviser on a team with the U.N."

And from **Bill Cooley**: "I was honored by *Engineering News-Record* in New York on February 17, 1975, by being cited for achievement of significance to the construction industry in 1974, for developing a water cannon for rock tunneling. At present, I am working on underground hydraulic mining of coal under a Terraspace, Inc., contract from the U.S. Bureau of Mines."

Special congratulations are in order for **Bill Lambe** and spouse, whose three sons all had straight-A averages at M.I.T. for the 1975 spring term! Bill has his own geotechnical consulting business. . . . And from **Hank Bowes**: "Still with the space program, working on shuttle avionics as Director of Engineering and Development. Betty and I had our first grandson May 3, 1975." . . . From **Bud West** (Allen A.): "Best regards to all!" . . . A very brief note from **Floyd Jennings** says only "Retired."

Kudos to **Peter Elias,** who has been elected to membership in the National Academy of Sciences ("The basis of selection is actual scientific labor.") . . . Another erudite classmate, **Howard Bensusan,** has been promoted to full Professor of Biochemistry in the School of Medicine, Case Western Reserve University, effective July 1, 1975. Howard got his M.S. from Purdue and Ph.D. from Boston University.

Stanley I. Skelskie was recently promoted Vice President of Herbert V. Shuster, Inc., an international consulting organization of the food, drug, cosmetics, and soft goods industries in Boston. Stan, in addition to his professional accomplishments, participates in civic affairs, serving as Chairman of the Board of Health in Westwood, and as a member of the Massachusetts Department of Public Health Task Force on Budgets. . . . **Andrew Corry,** of West Newton, Mass., was named Vice President-Electric of Boston Edison Co. He will be responsible for transmission and distribution, electric and system operations of all engineering and construction activities except nuclear. Andrew presently represents the U.S. on the Cable Committee of the International Conference on Large Electric Systems. So if New England suffers another blackout, we'll know where to point the finger, I guess.

Unfortunately, we've received reports of the passing of several of our classmates in recent months. **Sumner Ackerman,** of Brewster, Mass., passed away on June 8, 1975. Sumner, at the time of his passing, was a practising electronics engineer and a member and clerk of the town planning board and civic action group. We all send best wishes to Ruth, his devoted wife.

Joe Schaefer, of Weston, Mass., died on October 5, 1975. In recent years, Joe was a financial consultant, but formerly he had been Treasurer of Horn & Hardart Co., in Pennsylvania. In 1963 he became Treasurer of Charles T. Main Engineering Co., Boston. Our condolences go to his widow, Jane.

Tom Dolan, of Middleton, Mass., passed away on October 26, 1975. At the time of his passing, Tom was employed as Safety Engineer at the American Biltrite Rubber Co., Cambridge. For many years, Tom served on the Board of Selectmen of Middleton, finishing his tenure as Chairman in 1972-73. Our sympathy goes to his widow, Judy.

Let's have more *cheering* news from each of you! And thanks in advance. — **John L. Hull,** President.

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Our last comment was Merry Christmas and now it is "Happy Easter and have a pleasant Spring." Time rolls by with not too much news from you guys and gals.

Unfortunately, we have another death to report — **Julian Gammon** in Pittsburgh on November 6, 1975. Most of you will remember Julian as the Deke's dapper blond bomber, better known as the "Jacksonville Jumper." He was a Chemical Engineer for the Industrial Products Division of Dresser Industries, was a member of the University Club, Fox Chapel Golf Club, Rolling Rock Club of Ligonier and Shadyside Presbyterian Church. Surviving are his widow, Mrs. Peggy Conti Gammon; two sons, Julian III and John; two daughters, Alyce and Lelia; and a sister, Mrs. Jeanne Haughton of Jacksonville, Fla.

Stanley M. Brown, Jr., was recently named National Sales Manager of New Britain Machine Division, Litton Industries. Brownie is one of those rare individuals who has never changed employer; he joined the company in 1947 as an Administrative Trainee and after 20 years in various field sales positions was named Assistant Sales Manager in 1968. . . . **Curt Beck** advises that he is now President of the Pampa Texas Independent School District. . . . **H. Paul Grant** is on the downgrade: he reports that five of his eight kids are either through college or well on the way — up for air in '82! Last summer Paul did a little cruising around Block Island in his Oday 22. . . . **Charlie Patterson** spent late November-early December down under in Australia.

Random Christmas greetings: The **J. J. Strnads** advising that Jeff is now at Yale Law; Lyse, a field hockey star at Stanford; Nina, a Radcliffe sophomore; wife, Edna, Development Director at Hathaway Brown School; and old J. J. still running Lempco. . . . Jean and **Chris Boland** hoping that Son, Dick, makes the Institute in '80. . . . **George "Curly" Bickford,** our tennis player and ski-patrol worker (at his advanced age!), manages Carrier Corp.'s Service Park Center and Physical Distribution Engineering System. Lou and **Pete Hickey** are well — until Frannie and I take them on at bridge next Saturday eve!

A great picture from the **Sherry Ings** in colorful Hawaiian dress with the calm Pacific Ocean in the background. . . . A nice note from Jimmie and **Tom Stephenson** advising that they have stopped counting the passing years — not enough toes! Oldest son, Dave, finishes law school in the Spring while Gary graduated from Clemson last summer as a geologist. . . . Norma **Hetrick** advises that **George** just opened another office in Lancaster — real estate, home building, plant sites, and you name it! . . . **Nick Mumford** and **George Upton** continue their associations with LTV in Michigan and Texas, respectively.

Jim Hoaglund, President of McQuay Group of McQuay-Perfex, Inc., with headquarters in the Minneapolis-St. Paul area, forwarded a copy of Hoagie Christmas letter which describes a trip across four continents for Christmas, 1974. One goal was to see daughter Nora's Swazi "family" in their primitive surroundings and the country where she has spent the past two years. Last year's decline in building construction necessitated several layoffs in McQuay's work force, which made 1975 not too auspicious a time to take the McQuay reigns. Prospects look better for 1976, however. The challenge of the job is always interesting, and Jim thinks he has built a good working team. The joint venture in Brazil is now in operation, so McQuay products are man-

ufactured in both Americas, Europe, Africa, and Australia.

Mary is working full-time as Coordinator of Educational Research and Program Evaluation for the Edina Public Schools ("the length of the title is in inverse ratio to the status of the job," writes Jim); she's responsible for most of the testing in the district, as well as research and evaluation for two high schools and eight elementary schools. Her Ph.D. thesis is in the revision stage, with final oral tentatively scheduled for March. (What these Wellesley girls won't do for recognition!)

— **C. H. Springer**, Secretary, P.O. Box 288, New Castle, N.H. 03854

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Ernie Buckman reports 1975 was a tough year to be in the real estate business, but that Oliver Realty is healthy, growing, and optimistic. Ernie was recently elected Secretary-Treasurer of Building Owners and Managers Assoc. International, and feels he is probably the first M.I.T. graduate to be elected to national office in that trade association.

Lewis T. Mann, Jr., has returned to California and is the clinical chemist at Fresno Community Hospital, a private volunteer hospital with 350 beds. . . . **Morry Chomitz** reports his older son, Ken, graduated from M.I.T. in June, 1975 in mathematics. Morry has been with Day & Zimmerman, engineers and contractors, in Philadelphia for ten years, the last few years as Manager of Project Engineering. Morry has been widowed since 1969.

Don Burke and his wife, Pat, are looking forward to our 30th Reunion in June; they plan to bring their four children. . . . Mary and I expect to bring five or six of our brood to the reunion, and urge all of you to send in your reservations. . . . A note from **John L. Bateman,** advises he is back in Long Island after three years' residence in Boston. He reveals that sailing off Long Island is almost up to Boston Outer Harbor sailing. . . . **Robert F. Nelson, Jr.** is working at the Naval Weapons Center in the California desert. He is on an exchange program from the Naval Intelligence Support Center. His wife, Marianna, two daughters and a son are with him; son Tony is in the Navy.

Hill Dickinson is currently assigned to Army Staff, managing research, development and acquisition of army equipment.

Dave Sherrick's son, Bob, is a 1975 M.I.T. graduate; he finished in three years.

Some of you may have read in the February 2 issue of *Business Week* of the recent appointment of **Alan R. Gruber.** The court-appointed trustee of the fraud-ridden Equity Funding Corp. has named Alan as chief executive of the successor firm. Alan's appointment was approved by the Federal Judge who is supervising the company's reorganization. Alan was most recently President of Triumph American, Inc., subsidiary of a British banking group. Previous managerial positions were at Boeing, Xerox, and Heublein. Alan is to give Equity a new name and will move headquarters to Parsippany, N.J.

Ernest G. Jaworski has been elected to the Board of Trustees of the Gordon Research Conference, Inc., and is chairman of the Honors and Awards Committee for the American Society of Plant Physiologists. . . . **Robert L. Jacks** was just elected to a three-year term as National Director of the Council of the American Institute of Chemical Engineers.

We sadly report the death of Mildred Heuchling, wife of **Theodore P. Heuchling,** in Boston on November 22, 1975. — **Russell K. Dostal,** Secretary, 18837 Palm Circle, Cleveland, Ohio 44126

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Congratulations to **Mary Wagley** on re-election to a five-year term with the M.I.T. Corporation. . . . **Gil Parker,** still with I.B.M., is now in Paris. . . . **Earl Iselin** still teaches at the University of Dayton and has a new assignment as coordinator for cooperative education in engineering.

Harvey Miller is President of the Brookline (Mass.) Rotary Club and Commodore of the Charlesgate Yacht Club. . . . **David Lull**'s family is scattered over the U.S. He lives in Virginia, his son, Geoffrey, works in Boston; daughter, Christina, works for the City of Evanston after graduating from Northwestern; and son, Lawrence, is in Naval Training at Great Lakes. . . . **Dick Mooney** and six others recently received their N.J. State Charter for the Bernards State Bank of Bernardsville.

Fred Grant challenges any classmate to a bicycle race at any distance from five to 100 miles. Since his disability retirement in November, 1974, he has pedaled over 10,000 miles. — **Dick O'Donnell,** Secretary, 28516 Lincoln, Bay Village, Ohio

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Ken Brock is traveling 60 per cent of the time as part of his responsibility to work up an organization for M.I.T.'s campaign for capital funds. One of the fringe benefits of Ken's job is being paid to visit old friends. Ann and Ken are having a cottage built at North Truro about a mile from Corn Hill. With the Franklin stove they are installing, they expect to use the cottage from April to November. Ken's son has always been an avid horseman and has helped care for the horses at a neighboring stable. Recently his interest has broadened into several areas including academic studies.

On October 15, 1975 **Denny McNear** was appointed Vice President-Operation for Southern Pacific Transportation. This system includes the St. Louis Southwestern Railroad (S.P.'s cotton belt subsidiary) of which Denny also became President on November 1, 1975. . . . **Robert Hulsizer** has been a professor of physics at M.I.T. since 1964. . . . **Maurice Rifkin**'s son, William, is a sophomore at M.I.T. . . . **F. W. Furland** began working as an electronic engineer for the Dept. of Commerce, County of Los Angeles in late March, 1975. He enjoys his job and both Rita and he love their new house. The big Tujunga fire was stopped behind the house across the street from them. They even evacuated for four hours. Close! . . . **D. Towse** is working on energy research at U. of Calif. Lawrence Livermore Laboratory. He has published and lectured on geothermal resources and economics and on reservoir geology studies. . . . **Robert Hirsch** is vice president of Hirsch Broadcasting Co., which operates KFVS-TV. . . . **Bud Garforth** has purchased a second Gingiss Formal Wear Center — this time in Greenville S.C. His son Donald is managing this store.

Barney Devins retired from the DuPont Co. on April 30, 1974. If he had known how good retirement is, he never would have started work. . . . **Howard Finkel** retired in December, 1975 as Supervisory Architect from the U.S. Navy's Supervisor of Shipbuilding Department in Newport News, Va. . . . **Ed Kratovil** is preparing for retirement in 1981 at age 55. He has built a "country" home in Pinehurst, N.C. Ed will be changing from a county population of 6 million in Chicago to 30,000 in Moore County, N.C. . . . **Chuck Licht** is into pollution control and noise abatement. Although I don't believe him, Chuck claims that noise abatement involves keeping his mouth quiet once in a while.

Bob Wattson is Professor and Associate Chairman of the Aeronautical Engineering Department at Tri-State University. . . . **John M. D. Walch** is active in social welfare activities. John is a member of the planning and operations committee of the N.Y.-N.J. Regional Council of the Family Service Associations of America. John is also serving as a chairman of a sub-committee of the Agency Relations and Allocations Committee of the United Way of Essex and West Hudson, N.J. John is Senior Warden of Grace Episcopal Church in Nutley. — **S. Martin Billett,** Secretary, 16 Greenwood Ave., Barrington, R.I. 02806

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As I write this column, it is Tuesday, January 27, and yesterday Rio de Janeiro posted the highest temperature in 30 years (106°F.), apparently in compensation for the rumored 17° below zero record in New York City earlier this month. It is almost as if everything in the world is polarizing to extremes. Sonya and I are now looking forward to returning to the Boston area in May. I am looking forward to more contact with the Institute and to a fuller role as Class Secretary.

William S. Hutchinson reports his retirement from Flood & Associates, Inc., in Jacksonville, on November 1, 1975. "Will practice on my own, working on objective evaluations of environmental alternatives, principally in solid waste, nuclear power and covert military tactics." . . . **William E. Dennis** reports in as a Project Engineer, River Towboats, for St. Louis Ship. . . . If I understand his note properly, **William R. Chalker** is Principal Consultant, Environmental Engineering, for E. I. duPont de Nemours & Co. in Wilmington, Del. He is also in *Who's Who in America* and is Vice Chairman on the Air Quality Committee of the Manufacturing Chemists Assoc. . . . **Philip A. Lynn** reports that he had a full and complete recovery from his open heart surgery in November, 1974. He returned to work as a Project Manager for Turner Construction Co. in March, 1975. "Both Turner and I are still going strong." . . . **Frank P. Coy** reports that he has recently become Corporate Director of Management Information Systems for Echlin Manufacturing Co. in Branford, Conn. . . . **Ray Dujack** "foresook the corporate existence in August, 1975, for a position with the F.C.C. on the Special Projects Staff at the Chief of the Common Carrier Bureau. Leaving the New York City area has

been somewhat of a trauma: gone, our rent-controlled apartment in Greenwich Village and spur-of-the-moment weekends in Stowe or Cape Cod. Working with my new colleagues at the commission has, however, been a more than adequate compensation."

Walter E. Seibert reports that as of December 15, 1975, "I continue with the Petroleum and Minerals Div. of Chemical Bank (N.Y.) as Vice President, Mining. Today our group was moved from 20 Pine St. to 277 Park Ave., fifth floor." . . . **Peter K. Stein** is now President, Stein Engineering Services, Inc., and full Professor of Engineering at Arizona State University. In 1975 he was elected Fellow of the Society of Experimental Stress Analysis; elected by national ballot to the administrative Committee of the Instrumentation and Measurement Group of the I.E.E.E.; appointed by the National Academy of Sciences to Evaluation Panels for the National Bureau of Standards in the Div. of Electronic Technology and also in the Div. of Mechanics. He is still organizing five-day short courses featuring the Unified Approach to the Engineering of Measuring Systems developed by him some years ago; the 115th such course is scheduled for February, 1976.

We learned in December that **Edward M. Berly,** of Newton Highlands, died on September 9, 1975. . . . Just this moment, I received a notice that **Peter Whoriskey** died in November, 1975.

To close the column on a less somber note, I look forward to seeing as many of you as possible in June at Alumni Day, when **Paul Weamer** promises that we will have an opportunity to meet Bob Morison, the Class of 1949 Visiting Professor for this Academic year. In the meantime, best wishes to all. — **Frank T. Hulswit,** Secretary, Barão de Torre, 263, Co2, Ipanema, 20000 Rio de Janeiro, RJ, Brazil

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Kenneth D. Garnjost, Corporate Technical Consultant and Vice President of Moog Inc. of East Aurora, N.Y., participated in a two-week technical symposium in the People's Republic of China this winter. Ken explained to the Chinese the application of servo technology to machine tools. After China, he spent a few days in Tokyo where Moog has a sales-engineering division. . . . **Paul Kruger** has completed a leave of absence with N.S.F. and E.R.D.A. and is back as Professor of Nuclear Civil Engineering at Stanford University. Paul has been elected Fellow of the American Nuclear Society.

Since graduation, **Jack C. Acton** has spent his total professional career at General Electric. Since 1972 Jack has been general manager of the housewares engineering department, to which all the managers of engineering for the company's small appliance products report. He is a registered professional engineer in the states of New York and Pennsylvania, and a director of Integrated Display Systems, Inc. . . . **Les Allison** is general manager for designed products of Olin Corporation. Les lives in New Canaan, Conn. . . . **William H. Culver** is president of OPTELECOM, Inc., which develops and produces optical communication systems for the government, and of Newfound Corp., which is developing land in the Caribbean. Bill's family consists of himself, one active wife and three wild children. . . . **Joe Oppenheim** is taking a course at Brevard Community College in Cocoa, Fla.

We regret to announce the death of **Robert E. Nahm.** He was vice president of Orange and Rockland Utilities, Inc. and was chairman of the planning committee of the New York State Power Pool. He was also a member of the managing committee of the Delaware River Basin Utility group, the Edison Electric Institute, and other professional organizations associated with the electric industry. He is survived by his widow, Nancy; one son, Robert Jr.; and a daughter, Mrs. Karl Schneider.

George J. Marlowe completed his assignment as executive vice president of Nihon Oxirane Co., Ltd. in Tokyo, Japan, and has returned to Scientific Design Co., Inc., as executive vice president. . . . **Gerald A. Lessells** has been appointed a Fellow in the American Institute of Chemical Engineers. Gerald also received the Service to Society Award from A.I.Ch.E. for over 20 years of activities on behalf of equal opportunities for minorities. The award was presented in December, 1974. . . . **Alan G. Bates** was named vice president and general manager, Agricultural Chemicals Division of I.C.I.-U.S. . . . **A. Craig Hood** has been elected a Fellow of the American Society for Metals for his "distinguished contributions in the fields of metals and materials." At Standard Pressed Steel Co., he has overall management responsibility for the company's anaerobic adhesives products and its Joint Control System, a new concept in fastener tightening.

Donald R. Miller, vice president and eastern region manager of Cresap, McCormick and Paget Inc., was appointed to the newly-created post of director of professional services. He will be responsible for and direct C.M.P.'s professional practice development and marketing efforts. Don joined C.M.P. in 1956, prior to which he had extensive experience in supermarket retailing operations. Don was named director-North America, of the International Association of Chain Stores, effective January 1. He is also a member of the National Retail Merchants Association, The Travel Research Association, The M.I.T. Alumni Advisory Council, Sky Club and director of the Volunteer Urban Consulting Group of New York. . . . **Harry R. LaTowsky, Jr.** recently joined the consulting firm of Raymond Eisenhardt & Son, Inc. (Oakland, N.J.) as vice president. The firm operates internationally and specializes in packaging. Harry will be moving his family to New Jersey early in 1976. . . . The sale of **David E. Webster**'s book, *To Love and To Cherish,* C. R. Gibson Co., has now reached 300,000 copies. Also, David won the 1975 Nantucket backgammon championship. . . . **Joe Glasgow** is retired from the Air Force (1974) and is now working for the Hughes Aircraft Co. as a senior staff engineer. . . . **Norton Belknap** continues as a vice president of the Exxon Corp.

Nancy and **Jack Wilbur** report that their son, John, who is a graduate student in urban planning at M.I.T., was married in May of 1975 to Margaret Gerling of Columbus, Ohio. . . . In July, **Robert B. Leonard** was transferred to Montana from New Mexico Highlands University, Las Vegas, where he spent the last two years as U.S. Geologist Survey Visiting Professor of Earth Science. Bob's present assignment is as project chief of a regional geothermal-hydrology project. . . . Colonel **Walter R. Hylander** retired in 1974 and is now supervising construction training at Bechtel Power Corp.'s Grand Gulf construction site. He received a letter of commendation from the Acting Secretary of the Army for developing an apprenticeship construction program for Army enlisted personnel. Colonel Hylander obtained union recognition for this program. Colonel Hylander is married and has two college-age children, a son and a daughter. . . . **Thomas S. Maddock,** President of Boyle Engineering Corp., has new headquarters at Newport Beach, Calif. Also, new offices of Boyle Engineering have been established in Albuquerque, N.M., and Vienna, Va., outside Washington, D.C. . . . **Kenneth H. Olsen** is the president of Digital Equipment Corp., the world's largest manufacturer of mini-computers. Under Ken's leadership, D.E.C. has become one of Massachusett's leading industrial success stories. Ken is married and the father of a daughter and two sons. The family lives in Lincoln where he keeps a computer in the basement of his home. "They're wonderful toys for bright children," he explains. — **John T. McKenna, Jr.,** Secretary, 2 Francis Kelley Rd., Bedford, Mass. 01730

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The History of Science Society has named **Frederic L. Holmes** winner of the 1975 Pfizer award for his recent book about the great 19th-century French scientist Claude Bernard. The book is entitled *Claude Bernard and Animal Chemistry, The Emergence of a Scientist.* This award is given annually to an American or Canadian author of the best book in the history of science published during the previous year. Dr. Holmes, with his wife and three daughters, lives in London, Ontario, Canada. . . . **Ray Gruwell** has spent ten years on foreign soil. He is at present general manager of a Ralph M. Parsons Co. subsidiary in Frankfurt, Germany. His only child, Stephen, is preparing to enter university life in the U.S. . . . Traveling to Munich, Germany, is **Louis Weinberg** who will conduct a session on matroids at the International Symposium on circuits and systems. He is deeply immersed in the new field of matroids and combinatorics.

Three classmates have reached the vice president rank. **Franz H. Tyaack,** as Vice President of Westinghouse Electric Corp. has responsibility for industry systems division, Pittsburgh, Penn.; the computer and instrumentation division, Orlando, Fla., and industrial equipment division, Buffalo, N.Y. He had been general manager of the Westinghouse process equipment and systems division since 1972. In 1953 he joined Westinghouse as electronics engineer with the Company's Defense and Space Center in Baltimore, Md. He lives with his wife and two children in Monroeville, Penn. . . . Combustion Engineering, Inc. Windsor, Conn., has appointed **Paul L. McGill** Vice President, Commercial, with responsibility for preparation of nuclear proposals, carrying out steam supply system projects, licensing of nuclear projects and for project services. He joined C-E in 1968 and has served as manager of nuclear proposal engineering, nuclear products manager and, most recently,

central regional sales vice president in Chicago. He will relocate with his family in West Simsbury, Conn. . . . Another vice president is **Evan Evans** who is also Director of the United Refining Co. of Warren, Penn. Evan and his wife, Natalie, anticipate their third child in the spring.

The consulting profession has also claimed three '51ers. **Dean K. Boorman**'s firm, Boorman and Dorram, city planning consultants of Montclair, N.J., has served over 30 communities in N.J. This firm is also engaged in site planning for private developers. . . . **Loring O. Lee** reports that his geophysical consulting practice is flourishing. He spent two months recently in the Northwest Passage and Northern Baffin Bay trying to solve drilling problems under very icy and other challenging conditions. . . . **Alexander A. Padis,** Gulfport, Miss., is Project Engineer of Booz, Allen Applied Research, a division of Booz, Allen & Hamilton, Inc., management consultants.

Walter Kinzinger, as group leader of MITRE in Washington is working on future national military command systems. In his off hours he coaches a soccer team and is active in scouting. His sons, Arthur, 14, and Bruce, 13, spent last summer learning a math course as taught by computer. . . . **Mel Rubin** of Lexington, Mass., is Reliability Department data analyst for Raytheon Co.'s Lowell production plant. . . . **Richard Hammer** of Sheridan, Wyo., has been elected director of the National Auto Dealers Association. His oldest son is in the class of '77 at M.I.T. **William A. Schoenfeld** is a general engineer for the U.S. Navy; also a retired U.S.N. Commander. — **Fred W. Weitz,** Secretary, 4800 S. W. 74th St., Des Moines, Iowa 50321

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Politics is the new field for **Bob Schwanhausser.** He is Campaign Chairman for Vernon T. Yoshioka '60, for 77th California Assemblyman representing an area near San Diego. Bob has had a very active career since his graduation in aeronautical engineering, beginning with two years in missile flight test work at the White Sands Missile Range, then at Teledyne Ryan Aeronautical for 20 years, and now as President of Condur Engineering Corp. At Teledyne he worked through the engineering department to become successively Vice President-Aerospace Systems, Executive Vice President-Programs (Electronics and Aerospace Divisions), and Executive Vice President-International Programs. He was cited in the 1971 "Annual Laurels" of *Aviation Week* as the man "who put together, directed and sustained the obscure 'skonk works' that produce hundreds of special reconnaissance drones under routinely tight schedules to meet ever-changing requirements and provide superior operational performance," and, also in 1971, the San Diego Section of A.I.A.A. named him for "Outstanding Contribution to Aerospace Engineering." . . . **Dana Mayo,** who is Professor of Chemistry and Chairman of the Department at Bowdoin, spent the winter and spring of 1975 in Waltham Abby, England, just north of London, on theoretical studies with L. J. Bellamy, Director of the Explosives Research and Development Establishment there.

Dick Lyle is studying national security issues in the two-year Army War College Department of Corresponding Studies, expecting to graduate in July. He broke the Chevron Research/War College routine with an 80-mile west-to-east trans-Sierra backpack in August from Mineral King: "magnificent country!" . . . **Cliff Sayre** is presently Materials and Distribution Manager for the Polymer Intermediates Department of du Pont in Wilmington, Del.

Clifford H. Morse has relocated to Houston to become Vice President of the widely known architectural firm of Caudill, Rowlett and Scott. . . . **James R. Strawn** has just completed a term as President of the Denver Geophysical Society, host for the 1975 convention of the Society of Exploration Geophysicists. Jim observes, for the benefit of us Easterners, "We're trying hard to find some more oil and gas for you! Hopefully your congressmen will stop trying to make it more difficult for us." . . . **Tim Brown** is currently working on avionics testing for the space shuttle program at Johnson Space Center. Tim's wife, Bunny, is director of a girls' camp in North Carolina, and he has two sons (one graduates from high school this year and is a big tennis player, the other about to become an Eagle Scout) and one daughter (still winning horse shows).

Northwestern University announces that **Gustave J. Rath,** Director of the Design and Development Center and Professor of Industrial Engineering and Management Sciences, is a fellow of the Institute of Medicine of Chicago. . . . **Stanley H. Gelles** has left Battelle Columbus Laboratory to set up his own materials research and metallurgy consulting firm in the Columbus, Ohio, area; he has been active in beryllium and tungsten research and development. Stan's wife, Rhoda, is a school psychologist in the Worthington, Ohio, public schools, and they have three children — a son at Harvard, and daughters in high school and fourth grade. — **Arthur S. Turner,** Secretary, 175 Lowell St., Carlisle, Mass.; **Richard F. Lacey,** Assistant Secretary, 2340 Cowper St., Palo Alto, Calif.

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Dear Fellow '53ers: Sorry that an issue was missed, but the editorial staff and I disagreed on some editorial principles, thus stopping the presses. Hope that all will sail smoothly hereafter. In the interim, a number of notes, Christmas cards and other such memorabilia have collected, the contents of which I will share with you, part now and part later.

Sorrowfully, I must report that **Katherine (Kavanagh) Hansen** died on December 3. I have no other details at the moment, and if any of you want to share information, I will be happy to pass it along. . . . **Dedy Saban** recently became Senior Vice President and Director of International Operations of Cramer Electronics, Inc., Newton, Mass. Sounds like a tough break, as he will be responsible for directing all sales and operations in Canada, London, Rome, and Milan and will lead expansion in major cities throughout the world. Previously, Saban held major posts with the Fairchild Semiconductors and I.T.T. Semiconductors. . . . MITRE Corporation has reorganized yet again, only this time has "done good." As a result, **Gerald Langelier** will head the newly formed Airborne Systems Analysis and Test Department (one which supports the Air Force's Airborne Warning and Control System).

From the Alumni Fund contributions mail bag: **C. L. Fredericksen** wrote that he retired from the Air Force on Sept. 1 and is now a mathematics instructor at Fayetteville State University in N.C. [Ed. *Retired*? Good grief! We aren't *that* old — are we?] . . . **Roy Blackmer, Jr.,** signed in: "My major current activity is looking for a job. Since opportunities in meteorology are rather limited I would like to find something in the general area of working on alternative energy sources." [Ed. Perhaps **Bill Gouse** or somebody else has wind of something. At any rate, keep in touch.] . . . **David Klepper** noted that "current acoustical consulting projects include Federal Reserve Bank Building in Richmond, Va., and a Science Center, with a Space Theatre, for Detroit, Mich.; a slowdown in the New York area has been compensated by work nationally." . . . **J. Medgyesy** is still Vice President, General Manager, and part owner of Matrix, Inc., in East Providence, R.I. — proving (I guess) the old axiom, if you can't fight 'em, buy 'em. He adds, "In addition to our custom molding business for industrial customers, we are in the midst of launching our first proprietary product, a decorative but scientifically designed feeder. Carolyn continues active, and both our children graduate from different colleges this June." . . . News from **Ed Colbeth**: "Still working for American Cyanamid Co. in Wayne, N.J., in the Information Services Dept. Both boys are now in high school (freshman and sophomore). As a family we enjoy camping (although sometimes I think we should hire ourselves out as rainmakers) and tennis." . . . **Alan Smith** is presently Manager of Process Engineering in Monsanto's Corporate Engineering Dept. in St. Louis; three children: Karen, a junior at the University of Montana; Dale, a sophomore at the University of Kansas; and Laura, a sophomore in high school.

Charles Forman was just promoted to Director of Manufacturing Operations, Agricultural and Veterinary Products Division of Abbott Laboratories, responsible for all production, worldwide, including two vaccine plants in the U.S. plus agreements all over the world, including licensing in U.S.S.R. and Bulgaria. . . . A line from **Lloyd Siegel** reports, "After almost a decade in public service I'm going back into private practice as a consultant in health planning and facility design."

All for now. Will get to the up-datings from Christmas cards and such next issue. In the meantime, drop me a note or call. Or do something newsworthy. That is, get your name in print, and then send along a clipping, because the M.I.T. clipping service has perforce been contracted (budget, you know?). — **Martin Wohl,** Secretary, 7520 Carriage Ln., Pittsburgh, Penn. 15221

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Ron Kurtz is managing a metallurgical company in New Jersey, supplying tungsten darts to world champion dart throwers, Did you know that Ron and his brother Tony ('51) have instituted a lectureship at M.I.T. in name of their father (*see photo*)? Ron mentioned (in a phone call to **Wally**

Boquist) that he frequently sees **George Dormer, Mort Davis, Danny Lister,** and **Dick Lane.** Mort is an architect in New York City, Dan has a metallurgy company in Princeton, N.J., and Dick is now a lawyer in Washington, D.C.

Ron Stone, '59, of the alumni office recently visited **Bob Anslow,** Class Special Gifts Chairman, in California, and Bob is planning to initiate the gift program activities.

Jerry Cohen, Professor and Chairman of Northwestern University's Materials Science and Engineering Department, was named United States Co-Editor of the *Journal of Applied Crystallography.* . . . **George Lamphere** is Vice President of the Charles H. Tompkins Co., a Washington, D.C., construction firm, and **Bob Kerst** is Vice President of Midwest Constructors. . . . **Len Kranser** is making a name for himself by making nameplates for others. He is President of Miller Dial Division of Standex, the largest manufacturer of industrial nameplates in western U.S. He is also Vice President of the National Association of Nameplate Manufacturers.

Dean Jacoby reports that **Al Ward** is making the transition to California living without noticeable trauma. He is General Manager of the western area of USS (United States Steel) Supply, with plants in Seattle, Portland, San Francisco, Los Angeles, and Phoenix. One of Al's more notable accomplishments was tipping his sailboat over in Lake Tahoe. No report as to whether or not he was washed ashore at **Coley Bresee**'s condominium there; if so, I'm sure he would have received a cordial welcome. Keep up the good work, Al, the Olympics are only a year away! — **Dave Howes,** Secretary, Box 66, Carlisle, Mass. 01741; Assistant Secretaries: **Chuck Masison,** 76 Spellman Rd., Westwood, Mass. 02090; **Lou Mahoney,** 14 Danby Rd., Stoneham, Mass. 02180

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Now that spring is around the corner, you should stir yourself to send some news to the class secretaries. Anything will do — I recently wrote a note to myself when my itching stopped.

I received notes about two of our classmates who attended the 20th Reunion. Claire **Russell** wrote a nice letter and sent a clipping about **John**'s election to the board of trustees of the College Entrance Examination Board. He is the first representative of public higher education in Massachusetts to serve on the board. In previous years he has been chairman of a number of policy-making committees for college board. Claire writes that they have completed the move from Arlington to Marion (John is a professor of physics at Southeastern Massachusetts University). I gather that he is still busy with research at Brookhaven National Laboratory.

A note from Jeanette and **Frank Curran,** who were also at the reunion, informs me that they were expecting their fifth child in February. Last year they combined the reunion with visits to their Massachusetts relatives and trips to New York City and Toronto.

An item that deserved earlier attention is the selection by the National Society of Professional Engineers of the St. Louis Recovery System as one of the top ten outstanding engineering achievements of 1974. The recovery system is a full-scale demonstration plant, disposing of much of St. Louis' waste and trash piles while generating energy. The use of solid waste as a supplementary fuel reduces the requirement for coal by 10 to 20 per cent. The plant, which cost $3.3 million to build, has the capacity to handle one-third of the city's trash. The system was designed by Horner and Shifrin, Inc., which is the consulting engineering firm of **Walter G. Shifrin.**

Douglas R. Sullivan has made his way up the corporate ladder of Fairchild. He joined the firm in March, 1974 as Manager of Industrial Linear Integrated Circuits. Six months later he became General Manager of that division, and in April, 1975 he was promoted to Division Vice President. In June, 1975 construction began on a 250,000-square-foot plant devoted to the production of linear integrated circuits. . . . **Robert W. White** has been appointed Director of Facilities Management at the General Dynamics Electric Boat shipyard in Groton, Conn. He will be responsible for development of shipyard facilities, long-range facilities plans, plant engineering, and construction management. He has been employed at the shipyard since 1951, the last three years as Chief of Construction Engineering. . . . **Richard Dangel** is working for the Naval Sea Systems Command as the head of integrated logistics support programs, for which he recently received an outstanding performance award. He is remarried and living in Bethesda, Md., with his two children from the previous marriage and a third child, recently acquired. Dick wrote that he would appreciate hearing from some of his old buddies whom he missed on his trip to the Institute.

John W. Lyons, Jr. died suddenly on July 13, 1975 at his summer home in Bourne, Mass. A native of Cambridge, he was graduated from Annapolis in 1945. He served with the U.S. Navy for two years after graduation, and reentered the service during the Korean War with the rank of lieutenant. He worked for the National Airspace Administration in Cambridge for 12 years, and at the time of his death he was a metallurgist with the U.S. Department of Transportation. A resident of Belmont for 11 years, he is survived by his wife Patricia and his four children. Our sorrow and our sympathy go to his family. — Co-secretaries: **Marc S. Gross,** 3 Franklin Ct., Ardsley, N.Y. 10502; **Allan C. Schell,** 19 Wedgemere Ave., Winchester, Mass. 01890

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McIvor Edwards is Assistant Professor of Anesthesia and Physiology at the University of Pennsylvania, School of Medicine. . . . **Hans Hoeflein** returned to the U.S. a year ago and is now manager of industrial pump operations for Ingersoll Rand of Phillipsburg, N.J. . . . **Robert Johnson** reports he is a new member of the advisory committee for instrumentation at San Jacinto College in Pasadena, Tex.

Evan Jones was recently appointed Assistant Director of the Emulsion Research Division of Kodak Research Labs, Eastman Kodak in Rochester. . . . **Bill Leitch** at International Data Corp. is providing detailed news coverage of IBM's antitrust trial for the computer industry available on Infonet, Computer Science's nationwide timesharing network.

Larry Moss is now an independent consultant on energy/environmental matters. . . . **Max Plager** writes that they have moved to the suburbs (Highland Park), and he now teaches at Roosevelt University's suburban extension. . . . **Walter Sooy** is Vice President and Chief Scientist for Science Applications, Inc. The specialty is lasers and electro-optics. . . . Several months ago, **Sven Vaule** was featured on the financial pages of the *Boston Globe* in his new job as President of Jones & Vining. Sven first worked with the firm as a consultant a decade ago and helped this important supplier of shoe lasts convert from carved wood to molded plastic as its raw material. In the process, Jones & Vining also became an important supplier of molded plastic soles for shoes.

Don't forget the 20th Reunion — on campus the first weekend in June. Respond to the mailings or contact **Mickey Reiss** directly at 45 Sheffield Rd., Newton, Mass. 02160. — Cosecretaries: **Bruce B. Bredehoft,** Box 181, Dover, Mass. 02030; **Mrs. Lloyd Gilson,** 35 Partridge Rd., Lexington, Mass. 02173

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In February Arline and **Ed Friedman** of Hoboken, N.J., hosted a marvelous cocktail party and dinner for classmates in the New York Metropolitan area. I'll have notes and, thanks to **John Spencer,** pictures in the next issue.

Barnard Silver writes, "For the last year and a half I have been Managing Director for the Ivory Coast's new sugar operations located at Ferkessedougou. The project included 6,000 hectares of cane, the second largest dam in the Ivory Coast, a 5,000-ton per-day factory, a refinery, and the commercial sale of sugar in the Ivory Coast. The first sugar was produced on the eve of the 14th anniversary of Ivory Coast independence, December 7, 1974."

Guy Carbone has been appointed Senior Counsel to the Massachusetts Department of Labor and Industries and Special Assistant Attorney General. . . . **Bill Walsh** writes that he and his family have just returned from Germany so that he can begin a new assignment in corporate planning for Mobil Oil Corp. Bill says he and his family will miss Germany. They were enjoying the opportunity to investigate Helen's forebears and see the country. . . . **Gerald Murphy** was recently appointed Executive Vice President of the Potato Growers of Idaho, a trade association.

Scotty Patrick's story arrived in a news release from Ashland Chemical Co. He has been promoted to Vice President and General Manager of the Resins and Plastics Division, and is also responsible for operation of the company's maleic anhydride plant, now under construction in Wayne County, W. Va. . . . **Ernest Lustig** writes that as of September he has new duties which include not only the direction of the Division of Molecular Spectroscopy, but also those of Deputy Director of his Institute in West Germany. . . . **Arthur Poskanzer** is 1976 Chairman-elect of the Division of Nuclear Chemistry and Technology of the American Chemical Society. . . . **Julian Cherubini**

writes that he is President of Alimed Inc., a manufacturer and distributor of specialty medical products, especially in the field of rehabilitation.

Kenner Rawdon says he was married to Janet Peterson in July, 1964, and now has two children. He received his M.D. at Case Western Reserve University School of Medicine in 1968, and completed his psychiatric residency at Mass. General in 1972, where he is now a member of the staff. He has also maintained a private practice in Cambridge since 1972. Kenner is a member of the American Board of Psychiatry and Neurology, the American Psychiatric Association, and the Massachusetts Psychiatric Society.

Robert Holton writes that after ten years in Juliet, Ill., with Stauffer Co. and a construction company, he has joined Hinkel, Inc., in Teaneck, N.J., as Corporate Vice President of Operations, in charge of purchasing, distribution and all manufacturing activities at nine locations coast to coast.

My last note is an unhappy one. Mrs. **Joseph Norvell** reports that her husband passed away on July 27, 1975, due to cancer.

I'd appreciate hearing from any of you who might be traveling in the New York area; we could have lunch, or just chat on the phone. My telephone numbers are: business, (212)977-8655 and home, (212)865-1732. — **Fred L. Morefield,** Secretary, 285 Riverside Dr., New York, N.Y.

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Starting off on the academic front this month, **Frank Koppelman** finished his doctorate in transportation systems analysis at Tech last June and is now an associate professor at the Northwestern University and lives in Wilmette, Ill. . . . **Paul Todd** continues as chairman of the Genetics Program at Penn State and noted that two methods developed in his lab, density gradient electrophoresis of cells (Catsimpoolas) and radiation sensitization with ultrasound (Lele), have found their way into M.I.T. research activities.

Backs of envelopes brought greetings to the class from **Carlton Gebhart** who noted that the Gebhart's are expecting their first child on July 4! . . . **Glenn Zeiders,** who previously generated these monthly columns and recently declined to take up the task again, indicates that his major problem is finding a mediocre squash partner. In the midst of his enjoyment of play and work with D. J. Schafer Associates, Glenn also puts out a call for high quality personnel to work in the field of high-energy laser technology.

On the business and occupational front, **Michael Spring** bid adieu to the physics job market after completing his doctorate in x-ray physics at R.P.I. in 1974 and provides consulting services in the mini-computer field as a senior consultant with AGS Computers. . . . **Robert Kesell** notes that he is controller and associate research scientist for the Information Sciences Division of Rockland Research Institute in Orangeburg, N.Y. . . . **Neil Harper,** an active leader of the M.I.T. Club of Boston, is now the principal owner of Harper & Schuman, a three-year-old computer systems consulting firm, located in Harvard Square, which provides financial management services to the legal profession and to architects and engineers. . . . **Robert Hansen** was noted in the *Wall Street Journal* as the new Group Vice President of International Operations for Avon Products.

Very active in the Dallas area is **Walt Humann** who last year left his position as Vice President-Commercial Group of LTV to join Hunt Investment Corp. as Chief Executive Officer. In December, Walt was also elected President of Hunt Investment and Executive Vice President and Chief Executive Officer of Hunt Oil Co. He has been a strong supporter of community-based activities as one of the founders and now Vice Chairman of The Dallas Alliance and recently completed a four-year term as Vice Chairman of the Board of the Dallas Chamber of Commerce.

Special congratulations to **Chuck Crawford,** President of Kimball Physics in Wilton, N.H., who was the recipient of an award by *Industrial Research Magazine* for one of the 100 most significant new technical products of the year. The winning product, a lanthanum hexaboride cathode, is a key item in new super microscopes which can examine structures down to atomic size. Chuck had left his position as a professor at Tech in 1974 to assume the leadership of Kimball Physics, which manufactures scientific instruments for the high vacuum and surface physics industries. . . . Almost inundated with cement last year was **Emile Battat** who traveled extensively to Australia, New Guinea and Europe. When the Nigerian government cancelled letters of credit relating to cement imports, Emile was stuck at one time with three large cement cargoes without a home.

Ending on that constructive note, I close with our usual call for notes and letters. It only takes a few minutes to drop a note to **Phil Richardson,** 180 Riverside Dr., New York, N.Y. 10024; **John Amrein,** 770 Greenwood Ave., Glencoe, Ill. 60022; **Adul Pinsuvana,** 49 Seri Rd., Seri Village, Hua Mark, Bangkok, Thailand; **Bob Muh,** 907 Chantilly Rd., Los Angeles, Calif. 90024; and myself, **Allan Bufferd,** Secretary, 8 Whitney Rd., Newtonville, Mass. 02160

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When I received an envelope with the embossed return address, "The White House, Washington" (no "D.C." or zip code), a number of wild thoughts sprang to mind: the President had decided on a running mate, I was being recalled to active duty in a meaningful way, I was about to be asked to play "Whispering" on my daughter's ukulele at an important state dinner, and so on. Fortunately, it was a note from "Our Man in the White House," **Ray Waldmann** (who may have returned to private law and consulting practice by the time you read this). After working with A.D. Little, Inc., for six years as a consultant and assistant corporate counsel, Ray began a 2½-year stint with the White House's Domestic Council. Then followed several years with the State Dept., where he negotiated aviation and shipping agreements, headed delegations to a number of U.N. conferences, and helped establish international communications satellite systems. Ray recently returned to the White House to help prepare the Budget, the State of the Union program, and proposals for organization and control of the intelligence community. His avocational interests include tennis, skiing, and cruising on the Chesapeake with his wife and daughter, and Ray would like to see any alumni passing through Washington.

We travel from the White House to the Great White Way — West 58th St., actually — to find **Allan Shackleton,** who heads Monarch Releasing Corp., a film distribution company. He spent a number of years with the American Electric Power Service Corp. and the Columbia University Electronics Research Laboratory, where he worked on over-the-horizon radar and nuclear delivery systems. In 1969, a friend asked Allan if he would like to invest in a "porno flick." After brief research on 42nd Street, he found the product "utterly dreadful" but the theater filled, so he decided to enter the motion picture business. The business has been a success, and Allan sees an "extremely bright outlook" for the company, which currently is distributing a number of films, including "Snuff," "Penelope Tickle," and "Fantastic Invasion of Planet Earth" — which brings us back to over-the-horizon radar? Probably not, as Allan has no plans for returning to engineering.

A number of items came to us from press clippings and Alumni Fund mailing envelopes — which reminds me to remind you that your participation in the Alumni Fund is important, whatever the level of your gift. One of the measures of Alumni Fund success is the number of active alumni who contribute in a given year. With 11 more donors last year, our class's percentage would have equaled the average for all alumni. With your help this year, we can easily better that mark.

Richard deNeufville, M.I.T. Associate Professor of Civil Engineering, has won the 1975 award from the Special Programme Panel on Systems Science of the North Atlantic Treaty Organization for his paper on the analysis of large-scale public systems. . . . **Barry Karger,** Director of the Institute of Chemical Analysis and Professor of Chemistry at Northeastern University, is the 1975 Steven Dal Nogare awardee for research in chromatography. Application areas of Barry's research include bioanalytical chemistry, energy, and forensic chemistry. . . . And speaking of awards, we are happy to bestow our "I DO Loop"-of-the-Month award on **Ray Gumb,** who married Mary Ann Spriegel in May, 1975. Ray is Associate Professor of Computer and Information Sciences at Temple University, where Mary Ann is programmer-analyst. . . . **Stephen Scheinberg** recently was promoted to Professor of Mathematics and Associate Dean of the School of Physical Sciences at the University of California, Irvine, and he announces the birth of his daughter, Dianne, in January, 1975.

Ron Agronin reports that he was appointed Division Technical Director (at Kimberley-Clark, if earlier notes are current) after three years in marketing. He is active with the United Synagogues of America and is a member of the board of directors of the midwest region. Ron also is interviewing prospective M.I.T. students as educational counselor for Fox Valley. . . . **Gerald Kaiz** is manager of training consulting for the NUS Corp., where he is developing specialized training programs for the utility industry. He collects old electric trains (presumably of the model variety) and is interested in hearing from any class members with the same hobby. . . . **John Hartung** continues as di-

rector of wood products operations for I.T.T. Rayonier. Children, Robbin and Josh, are attending St. Michael's Montessori School, where John serves on the board of trustees. John and his family like to escape New York City's turmoil by heading for their vacation condominium in the Litchfield Hills of Connecticut.

Phillip Frink is Vice President and Resident Manager of the Seattle office of Piper, Jaffray, and Hopwood, a Minneapolis-based stock brokerage firm. Phillip, his wife, and three children find the great northwest to their liking. . . . Moving down the coast, we find that **William Nicholson** is Corporate Energy Coordinator at the Potlatch Corp. in San Francisco, while **Jon Claerbout** spends his leisure hours sailing the waters of San Francisco Bay with his wife and three sons. . . . **Susan Schur** reports that her most recent exhibition of paintings took place at the Nashua (N.H.) Arts and Science Center.

We still are interested in hearing directly from you about recent activities. — **Robert F. Stengel,** Secretary, 152 Oxbow Rd., Wayland, Mass. 01778

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In spite of my ardent hopes of several months ago, no 15th Reunion Committee has been formed. Since there was no way of telling how many people would be coming, I was forced to cancel our reservation at Castle Hill for the weekend of June 6. Sorry. In lieu of a real reunion committee I would like to invite you all to come to Cambridge this June to look over the Institute and meet old friends on an informal basis. M.I.T. will provide free dorm accommodations and the free use of athletic facilities. There will be a Tech Night at the Pops on Thursday, June 3. I will be glad to help you in any way that I can to find a place to stay, to get in touch with other classmates, and if there is a large enough group, to get a catered affair going. You can also get help from Joe Martori at the Alumni Office. His address is M.I.T. E19-438, Cambridge, Mass. 02139. Personally I am quite sorry that there is so little chance for a formal reunion this year. Both Helen and I honestly enjoyed the two other reunions — mostly because of the odd people we met.

We had a bit of a reunion over at my house the other day and several old friends came around. **Don Nelson,** looking clean and Scandinavian as always, came. Don has been job hopping recently and seems to have found a home at D.E.C. His wife, Lita, '64, is working and traveling for Millipore. . . . **Tony Lewis** still lives in Belmont and has taken up horseback riding and jumping. He is talking about moving out farther to be closer to his horse. . . . **Jerry Milgram** is still a professor at M.I.T. He spent last term over in my neck of the woods on a sabbatical at the Harvard Medical School working in a biophysics lab.

Last January I visited Cape Canaveral to look at the rockets. In one of the exhibit buildings, what should I see but a three-year-old photo of **Bill Lenoir.** Bill was a back-up astronaut for the Skylab missions a couple of years ago. Since the primary crews all were healthy, he never had a chance to go. I would guess that his chance will come up, if he cares to wait, in the space shuttle project.

Michael Bishop writes: "I have retired from the United States Navy and am now living on a farm on Cape Breton Island, Nova Scotia. In the process of restoring this farmstead I intend to investigate energy sources for application to this environment." . . . **William Dyer** wrote that he left the Air Force and now is a Plant Physician at the Tennessee Eastman Co. This means that he is in charge of the company's industrial hygiene program.

A beautifully written note came from **Scott Danielson,** who is obviously a graphic designer among his other accomplishments. His note said that he spent eight months last year in Italy doing consulting and painting. He was the graphics and design consultant for a new book out by Alitalia called *Pipe Airport System*: an advanced concept for airport planning and design. Just now Scott is an Architect and Urban designer for PBQ&D, Inc., in San Francisco. He is exhibiting paintings in the Bay area and is the director of the Westboro Music Festival in the Santa Cruz mountains this summer. And who says Tech men are dull?

Another director in our midst is **Avram Kalisky** who runs the National Physical Laboratory of Israel. He says he is a member of the honorary committee of CPEM 76 but I have no idea what that might be. Sounds important, though. . . . **Ira Dorf** is still an assistant director over at I.T.T. On the side he teaches management at Adelphi University's M.B.A. program on wheels. Those are courses offered on the Long Island Railroad that enable commuters to get a degree while on the train. Do you give extra credit when the train is delayed, Ira? . . . **John Savage** is also moving academically. He writes: "It has been ten years since I left M.I.T. with a Ph.D. in electrical engineering, specializing in information theory and coding. I have been at Brown University since 1967, and am now into computer science, specifically the complexity of computing. We (my wife and my two children) spent the 1973-74 academic year on sabbatical leave in Holland on a Fulbright and Guggenheim. I was promoted to full Professor in 1974 and I am the author of *Complexity of Computing* to be published by Wiley in 1976. I'm going to become an associate editor of the I.E.E.E. *Transactions on Computers* in January, 1976." . . . Another faculty member is **Max Keck** who is at John Carroll University's Physics Dept., in Cleveland. Max says that he got a research grant to do studies relating to the visual detection of moving patterns. This coming year Max will be a visiting professor at Ohio State in the Dept. of Physiological Optics.

A couple of lawyers in our class have taken up pen. **Leon Borstein** has finally gone into private practice after spending most of his career in public service. In the past, Leon's shingle has been hung up at the Peace Corps in Bolivia, the Brooklyn D.A.'s office, and at the special state prosecutor's office in New York. . . . **Barry Sacks** says he enjoys his new career as a tax lawyer and loves the San Francisco Bay area.

Over in the briny sea is **Peter Wells,** who is the national secretary-treasurer of the Flying Dutchman Class Sailing Assoc. Flying Dutchmen are an Olympic sailing class and we should be seeing them this summer in Montreal. Pete is the manager of engineering support at Simplex. . . . **Joseph Coburn** of the U.S. Coast Guard achieved the rank of captain last September. He is the industrial manager of the Coast Guard's Curtis Bay, Md., shipyard.

Rounding out this month's mail is a note from **Don Straffin,** who says that he longs to return to Boston to do actuarial type work, and a note from **Alan Weinberger** who is, you guessed it, a manager. Alan manages computer systems for Sperry Systems, in Reston, Va. His work involves management of the real-time computer systems for the Navy.

Finally it is my sad duty to report the death of **William Sacks** in Ontario, Ohio, after a short illness. He is survived by his wife, Elana, and two sons. Our sympathy goes to his family. — **Andrew Braun,** Secretary, 464 Heath St., Chestnut Hill, Mass. 02167

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Anthony J. J. Rourke, Jr. married Carolyn Rolston in January, 1974 and they expect their first child in May. He is president of the firm his father organized 20 years ago, Anthony J. J. Rourke, Inc. . . . **Barrett B. Roach** and Kate move back to northern California the first week of January with assorted Mexicana, their daughter, Molly (born Sept. 8, 1975), and a Mexican dog named Caperucita (Little Red Riding Hood). He returns to McKinsey's office in San Francisco. They will live less than a mile from brother John (M.I.T. '65) and his family.

Murray Schiffman received I-R100 Award for developing one of the 100 most significant technical products of the year 1974; the cover story of January, 1975 *Popular Science* mentions his invention and development of compressed/expanded speech technique, "Variable Speech Control"™ (VSC®). . . . **Jeremy E. Alperin** is still Chief of E.N.T. Service at Cleveland Metropolitan General Hospital in Cleveland. He was married in April, 1975. . . . **L. Marshall McCloskey, Jr.** is president of Integrated Navigation Systems Inc. (I.N.S.I.) supplying satellite/radio/dead-reckoning systems for energy and mineral resources exploration. He, his wife, and their four children (all boys) reside in southern California. . . . **Peter Anderson** and his wife Jane have lived one year in their new house, which Jane designed, and think it's great. He is an associate professor of computer science at New Jersey Institute of Technology. . . . **G.D.C. Antonini Pacheco** is married, has three teenagers, Matilde, Ingrid, and Tadeo. He teaches electric circuitry at Universidad Simon Bolivar. He is a member of the board of directors of the Venezuelan government-owned electric utilities corporation, and a member of National Council for Scientific and Technological Research. His main occupation remains as consulting engineer. . . . **Steven J. Brams** is presently teaching political science at New York University and his second book, *Paradoxes in Politics: An Introduction to the Nonobvious in Political Science,* was published in paperback by the Free Press division of Macmillan in February, 1976.

Theodore Sheskin is enjoying his second year as assistant professor of industrial engineering at Cleveland State University. He tells us that Cleveland has much cultural activity, despite its highly publicized crime and industrial pollution. . . . **Gerald L.**

Becker writes that after five years (1970-1975) as postdoctoral fellow, then instructor, in the Department of Physiological Chemistry at John Hopkins School of Medicine, Baltimore; he has accepted a new position — Assistant Professor, Department of Biochemistry, University of Alabama Medical Center in Birmingham. . . . **John Prussing** chairs the College Policy and Development Committee of the Engineering College of the University of Illinois. He is also listed in *Who's Who in the Midwest*. His wife, Laurel, is currently on the County Board and will run for County Auditor.

E. Finkin has a little girl, Suzanne Elkeh, born last April 8. . . . **Roger Rowe** is a program director at Public Technology, Inc. in Washington, D.C. P.T.I. is a non-profit research and development organization for states, cities and countries. He and Suanne have two children, Jocelyn and Christopher, and live in Rockville, Md. . . . **Xavier L. Simon** has been named General Manager of Kir Alimentos, S.A., a relatively new food processing company, which they hope to make one of the leading firms in Mexico. His wife, Gail, and three children, Valerie, Michele and Xavier are very thrilled with this new opportunity. — **Gerald L. Katell,** Secretary, Parking Structures International, 250 E. First St., Los Angeles, Calif. 90012

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February, 1976. A good harvest of envelope flaps this month — lots of news for you.

My first note certainly has to win the "chutzpah" award for nerve. **Ed Dudewicz** writes: "It's always interesting to read class notes in *Tech Review*; could you write to three or four class members a week (personal letters) asking for news? Maybe then we could read about those who never write." I immediately mobilized my huge secretarial staff and began drafting personal letters to our 700 some-odd classmates. At the rate of four personal letters a week it will take me about three and a half years to reach you all — so if your personal letter doesn't come in the next few years don't be alarmed, you'll get it eventually. In the meanwhile I'll continue to try reaching all 700 with your monthly *Tech Review*. And if any of you know some of "those who never write" you might either pass along my address, or collect the news and pass it along to me yourselves.

Ed also wrote that he was recently appointed U.S. Editor of *Statistical Theory and Method Abstracts* published by the International Statistical Institute. Ed's note (written in December) concludes with the information that he is still at No. 1, Ohio State . . . of course, with the greater wisdom that comes to us in the early days of January, I and my California compatriots from U.C.L.A. know how to respond to that comment.

Maternity/paternity data: **David Kelly** is the father of a new son, Joseph Creed Kelly, born October 15, 1975. Father reports that son has a fine set of lungs. . . . **Frank Cocks** reports the birth of twin sons, Elijah Eugene and Josiah Charles Cocks, May 30, 1975. Congratulations.

Don Yansen, '65, is living in Lexington, Mass., with his wife Lynne and two children, Tia, and Shana. He is working in the high-energy laser business for Science Applications, Inc., but spent the past summer working on a fishing boat in Alaska. . . . **Barry Roberts** is presently Chief, Cutter Maintenance, of the Naval Engineering Division at Coast Guard Headquarters. . . . **Barton Cramer** has recently been promoted to the rank of Senior Geophysicist at Chevron Oil. For the past five years Bart has worked at Chevron's Houston, Texas, Geophysical Division in the computer processing center. . . . **C. Forrest Tomes** is living in Cedar Rapids, Iowa, "where the air is clean and the railroads make a profit." Forrest's family includes his wife Bunnie and their two boys. Since September, 1974, he has been with Collins Radio/Rockwell International as Manager of the Test Equipment Section. His group manufactures, engineers, calibrates, and repairs test equipment for both in-factory use and outside sale.

> Careful readers may have noted an error in the caption to a photograph in this space in January (*page 117*): We identified as Mrs. Swerling a head-table guest seated next to Stephen Swerling, '63, who was shown as President of the M.I.T. Club of Boston with Congressman Robert Drinan. Red-faced editor apologizes: the lady was his guest, but Mr. Swerling is not married.

Michael Fitzpatrick writes that he enjoys reading *Technology Review*. (I hope I've contributed to that enjoyment.) He asked me to pass along a message to Robert Barret, '60 — Robert, get in touch with Mike — he has some good news for you. . . . Via the medium of an alumni fund envelope flap came the following message from Karen and **Marvin Singer**: "This is just a lazy way to say hello. . . . We've recently become harried homeowners and most of our spare time seems to be taken up with all kinds of 'arts and crafts.' " Welcome to the club!

I'll close this impersonal mass mailing with the wish that 1976 is treating you all well. More next month. — **Mike Bertin,** Secretary, 18022 Gillman St., Irvine, Calif. 92714

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Plenty of news this month, fellow Classmates. Your alumni fund envelopes have provided quite a bit of information, but no class heroes this month. How about it! We'd love to hear from you.

To the news:

Richard Adamec has recently been promoted from District Sales Manager to National Product Manager in the Marketing Services Division of Dun and Bradstreet. . . . **Mark Alpert** has written to tell of his wife Judy's recent achievement. She has received her master's degree in music education. . . . One of our classmates in academia, **Richard Boyd,** has received tenure as Associate Professor of Philosophy at Cornell University. . . . **Edward W. R. Casper,** a devotee of Shote Kan Karate, has attained the rank of Brown Belt. . . . **William Evers** works for Foxboro Co. managing a group that supplies computers for power plants. He and his wife Anne have one child, Billy.

Not only has **J. L. Friedberg** written about himself, but has also forwarded information about another classmate, his brother-in-law **Jay Tenenbaum.** The Friedbergs have recently relocated to Houston, Texas, where he is Manager of Geophysical Analysis with Aero Service (Airborne Exploration). They have two children. Jay Tenenbaum is at Stanford Research Institute. His wife Bonnie recently earned her Ph.D. They have a three-year-old son.

Jon Gruber is very proud of his new family addition, a son Wyatt as well as his two-year-old daughter Lindsay. The Gruber family is still enjoying living in San Francisco, where Jon is still a partner in Robertson, Colman, Siebel & Weisel, an institutional stock brokerage and investment banking firm. . . . One of our classmates in the medical field is **Robert Johnston,** who has now opened a private practice in ophthalmology. His practice is in Leesburg, Va., where he and his family (three children, one dog and one cat) live.

Leon Kaatz has informed us that he will be graduating from the University of Connecticut Law School this coming May. Congrats, Leon! . . . **Bruce Knobe** has written to fill us in on his career since leaving the "tute." He received a master's in math from the University of Illinois in 1966 and then his Ph.D. from N.Y.U. in 1972. Bruce then taught from 1972 to 1975 at the Hebrew University at Jerusalem. He is now working at Intermetrics, Inc. as a compiler builder. . . . **James W. Harrill** is a Lieutenant Colonel in the U.S. Air Force assigned to Hanscom A.F.B. in Massachusetts. His office is located in the MITRE complex in Bedford, Mass., where he is director of Administrative Management with the E-4 System Program Office.

Andi and **Marty Ormond** and their "three wonderful kids" are enjoying their recent move to the Allentown-Bethlehem, Penn., area, where Marty is currently working as a marketing manager for Pfizer, Inc. He invites any fellow classmates visiting the area to drop in with tennis rackets. . . . **Alan Press** is another of our feilow classmates in academia. He is an Associate Professor in the School of Social Welfare at the University of Kansas in Lawrence. . . . Still working as a systems engineer with IBM in Philadelphia is **Maury Shulman.** Maury and Rena are enjoying watching their new daughter grow up. . . . **Andrew Silver** has produced, directed, adapted, and edited a film called "Next Door" for WGBH Channel 2 in Boston, which was adapted from the short story by Kurt Vonnegut, Jr. Andrew says to look for it on your local educational TV station sometime this spring.

Doug Tuggle has also been busy. His first book was published this past summer titled *How to Program a Computer,* and his second book, *Organizational Processes,* is due out this spring. The Tuggles are also the proud parents of a new daughter. And to top it all off, Doug has even written about another classmates, **Jim Moore,** who is now at Information Science Institute in Marina Del Rey, Calif. . . . The **William Young** family is now living in Millwood, N.Y. Bill commutes daily to Manhattan, where he is a securities analyst covering the chemical industry for Morgan Stanley & Co. Having completed only his third year as an analyst, Bill was recently honored by being named to the *Institutional Investor Magazine*'s third All-American Research Team for his cover-

age of the chemical industry.

That's all for this month. Keep the mail coming. — **Steve Schlosser,** Secretary, 12401 Bobbink Ct., Potomac, Md. 20854

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Lots of news on the backs of Alumni Fund envelopes, and more from the hard-working Telethoners. Keep up the good work folks!

Dennis Bekeny has opened a private pediatric practice in New Haven, Conn. . . . **Scott Blouin** is enjoying the peaceful Vermont woods and putting his civil engineering skills to work building a house; the Blouins are also raising a family. . . . Sue Ann and **Bruce Bottomley** had their first girl, Karen, last summer. . . . **Art Bushkin** is a consultant for the Senate Government Operations Committee, helping answer technical questions about the Privacy Act of 1974. . . . Carolyn and **John Golden** and their children (Lisa, 9, Jenni, 7, John, 5, and Matthew, 2) recently moved to Summit, N.J., from Newton. John left Polaroid to become Manager of the Corporate Data Centers for the Schering-Plough Corp.; he continues to fly both land and sea planes. . . . **Walt Miller** has finished his residency in pediatrics and has his board certification; he is now a post-doctoral fellow in biochemistry at U.C.-San Francisco. Walt's future plans include research in pediatric endocrinology and wine-making. Classmates in the S.F. area are invited to call and try some home-made wine.

George McKinney has been promoted to Director of Business and Financial Planning (where are you working, George?). . . . **Charles Gholz** was the guest editor for an issue of the *American Patent Law Association Quarterly*. . . . **David Crawford** moved to Singapore in June, 1975, as Marketing Services Manager for the Asian operations of J.I. Case. Dave notes that he is "still single but looking." . . . **Peter Addis** is busy, consulting at Lexidata in Lexington, Mass., on minicomputer video displays, teaching FORTRAN at the M.I.T. High School Studies program, and working part-time on a Master's in Computer Science at B.U. Pete's three Mongolian gerbils are reported to be well. . . . **John Freed** has his Ph.D. in organic chemistry from Stanford and then spent two post-doctoral years in immunology at Stanford Medical School. He has just finished further post-doc. work at Albert Einstein College of Medicine and is now Assistant Professor at Johns Hopkins School of Medicine.

Eric R. Jensen is living in Manchester, N.H., automating newsrooms for Hendrix Electronics. He and the former Laurie Gutman (Wellesley, '70) are living on three acres within walking distance of work; a pleasant change, Eric notes, after 15 years in Cambridge. . . . **Steve Ivester** moved from Polaroid last spring to become Chief Mechanical Engineer for the Electronics Corporation of America. . . . Mr. and Mrs. **Leonard Logterman** have two children, Amy Jo, 3, and Julie Ann, 1; Leonard is Group Leader, Instrumentation, for the Cummins Engine Co. in Columbus, Ind. . . . **John (J.D.) Roach** has moved from Wellesley — still with the Boston Consulting Group, now in their Menlo Park office. He is currently trying to improve his tennis game and sample all the wines produced in northern California. Wife Pamela and daughters Vanessa, 5, and Alexandra, 3, are doing well in the sun.

Gordon Everest has been appointed Chairman of the A.F.I.P.S. Special Committee on Privacy, designed to be a voice of computer professionals before the government and public. . . . **Philip Smith** is financial director of Brand Rex Co., working on acquisitions and "keeping tabs on the companies' growth and profitability." . . . **Herbert Mower** moved from Tech in September to become a Radiation Physicist at the Tufts-New England Medical Center Hospital and is very happy in his new job; the Mowers have just moved to a new home in Andover. . . . **Ron Brinkerhoff** and Rosanne have almost finished a home they started seven years ago and are ready to start another. Ron says he is ready to try farming as a side-line to real estate and engineering. He wants to know what happened to the photos **Steve Dangel** took at the tenth reunion. — Steve, are you listening? . . . **Ron Mandle** joined Paine, Webber, Jackson and Curtis in May, 1975, as Vice President in institutional investment research; Ron and Linda had their first child, Dara Michelle, on March 25, 1975 — sounds as if 1975 was a good year for the Mandles. . . . It was also a good one for Martha and **George Moyer**; daughter Anne was born on January 17, 1975, and George was promoted to Vice President of the First National City Bank in November.

Thanks to you all for writing. Let's keep those cards and letters coming, folks. — **Edward P. Hoffer,** M.D., Secretary, 12 Upland Rd. Wellesley, Mass. 02181

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After recent record-high temperatures and drought, San Francisco today experienced a rare snowfall. Perhaps the Big Quake will have finished her off by the time you read this.

Larry-Stuart Deutsch summarizes his career since M.I.T.: first as an Independent Research Fellow in Biomedical Engineering at McGill University. Later, "forsaking the relative comfort of my research fellowship," he entered medical school and earned his M.D. from McGill in 1974. Now he is working as a Resident II in General Surgery at the Royal Victoria Hospital in Montreal and next summer will start as a Research Fellow in the Division of Clinical and Experimental Information Processing at the Academic Hospital Dijkzigt of Erasmus University in Rotterdam (Netherlands), where he will be working on the design of a new surgical ICU monitoring system. During the summers, he worked at Digital Equipment Corp. on various design and marketing projects, including the PDP-11/45 computer and a computerized cardiac catheterization system. Vacations and business trips have taken him from Alaska to Panama and Los Angeles to Belgrade, including two overland trips from Amsterdam to Istanbul and an overland M.I.T. expedition from Cambridge to the 1970 Total Solar Eclipse in Miahuatlan, Mexico. . . . **Ted Williams** is writing environmental impact statements at Barnes & Jarvis, Consulting Engineers, in Boston. Ted's article entitled "The Impact Statement — Some Problems and Answers" was published in the January issue of *Consulting Engineer* magazine. Kathy is in law school. . . . **Charles Suter** graduated from Medical School, University of Virginia, last September and now views his internship with trepidation. . . . When his company moved to New York City, **Stan Rose** found himself facing a one-way commute of one hour and 45 minutes. "At first you think you are crazy to spend so much time on trains until you see that your whole neighborhood is on the train with you; there is some comfort in numbers." Stan has been trying to organize an M.I.T. Alumni Club of Princeton. . . . **John Podolsky**, an independent consultant in computer operating system development, teaches a course in basic aeronautics at Glendale College, Calif. He recently passed the flight test for his airline transport pilot license. . . . **Ed Geltman,** still in the Air Force, will begin his cardiology fellowship at Barnes Hospital in St. Louis in July. . . . **Richard Storat** is project manager with B & W Nuclear Operations in Lynchburg, Va. . . . **John Child** is working in New York City for Davis, Hoxie, Faithfull and Hapgood, a law firm specializing in patents and trademarks. He lives in Philadelphia and commutes daily. . . . **Bill Christiansen** was present on July 4 for the birth of his daughter, Lynley Marie. . . . Byron and **Barbara Desmond Gilchrest** are the proud parents of Emerson Kane, born August 14, 1975. Barbara is in the last year of a dermatology residency in Massachusetts General Hospital. . . . **John Fadum** is doing research in manned interstellar speceflight and gravitation theory with the British Interplanetary Society.

It is ironic that **Larry Constantine's** book on computer program structure, *Structured Design*, became popular after he left the field; a Prentice-Hall hardcover version should appear this year. Larry recently delivered a paper on "Open Families" and would like to hear from anyone interested in Kid's Lib, children's rights and single-standard families. . . . **Ross Corotis** is newsletter editor for the American Society of Civil Engineers, Engineering Mechanics Division. He recently completed an N.S.F. research project on the use of computers in rainfall prediction. . . . **Bruce Barron** married Joan Solovay last August and is now at Ford. . . . **Louis Schwartzkopf** is Visiting Assistant Professor of Physics at Reed College. . . . In April, 1975, **Tim McGettigan** married Marika Krüger-Spilta, a German from Hamburg — **Jim Swanson**, Secretary, 669 Glen Rd., Danville, Calif. 94526

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We are saddened to report the death of **Eric Schindler** on November 29, 1975. At the time of his death he was living in Adelphi, Md. Our sincere condolences to his family and friends.

Len Hirschfeld "finally" received his Ph.D. in computer and information sciences from the University of Pennsylvania in August. He is now working for R.C.A. Information Services in Cherry Hill, N.J. He and Carol have bought a house there which they expect to move into shortly. Another recent graduate and homeowner is **Dave Seldin** who finished medical school in June and is doing a residency in diagnostic radiology at N.Y.U. He and Fran have a house in Queens, "among grass and trees again," from which he commutes. They report their son Jeffrey, 20 months, is very proud of his new sister, Shana, who was born on October 11. . . . Girls must be in style now for

we also have a note from **Rick Borken** reporting the birth of Sara on January 29, 1975, and Roberta and **Richard Plotnick** reporting the birth of their first child, Erica Jill, on September 7, 1975. Our congratulations to all and we hope to see these young ladies as alumnae in the class of '96.

Art Cole got out of the Air Force in August and now Joanne, '71, and he are graduate students at the University of Michigan. They write: "Gwen gets a little enjoyment out of going to school just like mother and dad, but when people ask her 'where does your father work' she has to answer 'he doesn't.'" They also add, "there's quite a collection of recent M.I.T. people here enjoying the easy life of a Big Ten football factory. **Eric Sweetman** lives across the parking lot from us, **Rick Johnson** lives nearby, **Andrew Jennings** visited Ann Arbor recently — as well as some people from other classes — Laura Middleton '71, Jan (Arey) Sweetman, '71, Dave Newman, '69; more than a living room full of old M.I.T. people." . . . **Dick Handler** is happily practicing medicine in Saranac Lake, N.Y., in the middle of his "own favorite mountains." His wife, Leslie, was attending law school in Albany where he had been a resident, but dropped out so he could get the practice he wanted.

After two years in the Public Health Service as a clinical associate at NICHD, **Richard Ehrenkranz** will begin a Neonatology Fellowship at Yale-New Haven Hospital and move into a renovated 150-year-old house in Guilford, Conn. . . . **Al Bernstein** spent three weeks during the summer on a Norwegian steamer going around the North Cape and Arctic Ocean. . . . **Curtis Marx** has left DuPont and joined the Polymer Corp. in Reading, Penn. . . . Our southernmost classmate continues to be my former roommate **Paul Forbes** who is working for the construction firm of Dorman, Long. In August he moved to Richards Bay, 100 miles north of Durban, South Africa. In January he moved on to Oranjemund on the west coast to help build a crushing plant for digging diamonds from the beaches. . . . The football bug has finally bitten **Barry Mitnick** at Ohio State where he teaches political science and public administration. He got tickets for the Buckeyes and spent his Saturdays at Ohio Stadium. He taught two seminars for the winter quarter and will teach an introductory course in public policy formulation and implementation in public administration in the spring.

William Hutchison is a minicomputer systems consultant, building commercial data entry and management information networks. . . . **Thomas Wylonis** has been working as an associate consultant with McKinsey and Co., Inc., in New York since May, 1975. . . . **Don Baker** spent ten days in October on a Bureau of Land Management-VIMS continental shelf baseline study cruise over future oil lease lands. He reports getting very seasick, which I suppose proves that the M.I.T. crew does not prepare you for such things, but "survived" to help take geophysical data. He will be working on BLM instrumentation for future cruises "probably not over water." . . . **Rick Klass** has started his own homebuilding company, The Magna Group, Inc., to build single family homes in suburban Washington. His wife, Karen, is a principal in the consulting firm of Hagar, Sharp, & Klass, Inc. . . . Howard Greenbaum, '67, is still at Bell Labs in the area of computer performance evaluation. . . . From sunny Florida we heard that **Paul Gluck** has almost completed his residency in OB-GYN ("at long last!") and will be joining a group practice in the Miami area. His wife will be practicing allergy in Miami. They recently co-authored a prize winning paper on "Pregnancy and Asthma." Paul was recently elected Secretary-Treasurer of the Southeastern U.S. Junior Fellows of the American College of OB-GYN. But all is not work; in their spare time the Glucks enjoy sailing, bicycling, and cheering the Miami Dolphins on to another Super Bowl. . . . That's all folks, we'll see you again in May. — **Gail** and **Mike Marcus,** Secretaries, 2207 Reddfield Dr., Falls Church, Va. 22043

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Burt S. Barnow took a leave of absence from his job at the University of Pittsburgh to work at the Department of Labor in Washington. His wife, Renee, is a writer/editor at the Federal Energy Administration. They like Washington because "it's nice to live in a place where you can breathe the air." . . . **Robert L. Bushkoff** works for Xylogic Systems, Inc. He and his wife, Paula, live in Sudbury, Mass.

Steve Dreher went on a two-month canoe trip last summer in Canada's Northwest Territories, on Thelon River from Lynx Lake to Baker Lake. The weather was excellent, the flies and mosquitoes were tolerable, but there were too many days of headwinds. Steve is now vacationing and job hunting on the East and West Coasts (as of January, 1976). . . . **Henry F. Faery, Jr.,** is studying for a Ph.D. in Aeronautical Engineering at Virginia Polytechnic Institute and State University in Blacksburg, Va. He is a Lieutenant Colonel in the U.S. Army. . . . **George Flynn** spent the last summer as an A.A.A.S. Mass Media Intern at *The Charlotte Observer* in Charlotte, N.C. He is participating in a study of cosmic ray and fission tracks in lunar rocks and meteorites, and working on a Ph.D. in Physics at Washington University, St. Louis, Mo. . . . **Sharon F. Grundfest** is moving from New York City to Cleveland in July, 1976, to become a surgical resident at the Cleveland Clinic for two years. She recently spoke with **Shelley Fleet Ackerman** who is at University Hospital in Cleveland.

W. David Lee works at Arthur D. Little in Cambridge and is responsible for managing several government-sponsored energy studies, including "Technological Options for Improving Refrigerator Water Heater Efficiency" for the F.E.A., "Aerodynamics of Trucks" for the French Transportation Ministry, and "Solar Collector Testing" for N.B.S. He is acting chairman of the A.S.T.M. Committee on Standards for Solar Energy Components. He and his wife (a third-year law student) live in Arlington and can be found most nights playing squash at the DuPont Center or with the crew at the Boat House.

Michael D. Meloy is flying DC-9s for the U.S. Navy from N.A.S. Alameda, Calif. . . . **Eugene F. Mallove** received his Sc.D. in June, 1975 from the Department of Environmental Health Science at Harvard for whom he now works. His current projects include research on air cleaning systems for the fast breeder reactor, consulting work on advanced space propulsion systems, and investigating UFO sightings near Holliston, Mass. . . . **James W. Marshall** is an assistant professor of economics and business at Muhlenberg College, Allentown, Penn. . . . **Tom Najarian** and his wife Sina enjoyed talking with their friends at the recent M.I.T. Telethon for the 1976 Alumni Fund. Their children Nova and Mark are in good health.

Stephen C. Pace lives in Salt Lake City and commutes to the mountains and the desert. His wife, Mary Ellen Sloan, is an attorney specializing in Indian law. Since leaving Sloan School, Stephen has co-founded an O.S.H./Health Maintenance consulting firm, managed accounting and planning for Sperry Univac Special Programs/A.S.D., and now manages accounting and budgeting for Envirotech Corp. . . . **John R. Selin** is still with Raytheon in radar design and now lives in Marlborough. A new addition to the family is second daughter Meredith. . . . **Bill Stewart** works as an engineer in a family-owned conveyor business. He teaches part-time and will complete his M.S. at Ohio University in Systems Engineering. He is contemplating various Ph.D. programs. . . . **Thomas Turai** is living happily and busily in a Philadelphia suburb with his wife Ann, daughter Missy (3), and son Stevie (9 months). He was recently promoted to staff consultant in the Honeywell Process Control Division. He is studying for an M.B.A. in finance.

Sue Udin is doing post-doctoral work in the M.I.T. psychology department. She is studying the processes underlying neuronal connectivity in the visual system. Her husband David, '66, and she are living in Brookline. They'd be happy to hear from their old friends with whom they have lost contact while immersed in their theses. . . . **Edward M. Waibel** registered as a professional engineer in the District of Columbia.

That's it gang. Be well, think snow and may you always land upright on the far side of your next mogul. — **Peter Peckarsky,** Secretary, 950 25th St., N.W., Washington, D.C. 20037

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The Class of 1971's Fifth Reunion is June 3 to 6. We will get free dormitory rooms as well as free use of recreation facilities, such as the tennis courts, swimming pool, sailing, etc. The Reunion Committee is planning social events for the weekend based on comments and suggestions they receive. The class still has a checking account with approximately $700. The Executive Committee is considering using it for the reunion, and was wondering how the class felt about this. Please send your comments to **Howard J. Siegel,** 228C Harrison St., Princeton, N.J. 08540, as soon as possible. *Mark our reunion weekend on your calender now so you don't forget.*

Our class gift originally was going to be the "Kent State Memorial Lecture Series," an unending series of annual lectures or debates paid for by the interest earned from our class gift funds. Unfortunately, our class gift is only $3,895.00, not enough to allow us to pursue our original plans. The Class Executive Committee is discussing (by mail) what to do with the money and we would like your ideas. We are considering: having one big debate; having a series of lectures until the fund runs out; or trying to come up with a

new idea. Please send your suggestions and comments to Howard J. Siegel at the above address.

Now for the activities of some of our classmates: **Ellen Koerber Sheridan** writes, "I'm leading the life of a hassled, overworked intern at the Peter Bent Brigham Hospital in Internal Medicine — but secretly enjoying it." . . . Dancing with the Laura Dean and Dance Co., and the Katherine Litz Dance Co., **Grethe Holby** is taking a leave of absence to sing, dance, and act in the Robert Wilson-Phil Glass Opera, "Einstein on the Beach" which will open in Avignon, France, and tour Europe and the U.S. . . . In August, **Ned R. Sauthoff** received his Ph.D., from Princeton in plasma physics at the Princeton Plasma Physics Laboratory where he is now employed. Ned married Ana Figueroa of Kendall Park, N.J., on June 21, 1975. . . . Congratulations to the **Chris Marlers** on the birth of their second girl, Emily Claire, born October 31, 1975.

Steve Ehrmann writes: "Leslie and I are now living at Apt. 18A, 2260 Division St., N.W., Olympia, Wash. 98502. On leave from my doctoral program at the Institute, I'm working on educational research and evaluation for the Evergreen State College. Evergreen is an exciting place. It was founded as an interdisciplinary institution and now it is seriously evaluating the results of the educational process (I wish M.I.T. would do as much!). The N.S.F. is financing the first two years of the work — I'm the "outsider" in charge. Olympia is rainy during the winter but I'm rediscovering how much I like rain. Leslie was the original reason for our breaking off in Cambridge to come here and she is really enjoying the opportunity to finally sit back and take her bearings. We won't be able to make the fifth reunion, a fact we much regret. Please write or give us a call if you're in the area." . . . **Leonard Tower** has been working as a comptroller for a printing firm going bankrupt. He says it's very interesting. . . . **Benjamin R. Roberts** (78 Tolentino St., San Lorenzo Village, Makati Rizal, Philippines 3116) writes that he married Judith Higgins, received his second master's degree from Stanford in '75, and is now with a Boston consulting firm in the Philippines. . . . **J. E. Rudzki** has been named the director of the Ground Systems Engineering Div. of the U.S. Air Force Security Service.

J. J. Guiniven received his Ph.D. in philosophy from the University of Massachusetts in September and is now teaching at Northwestern University. . . . **Daniel Weinberg** writes: "I have completed my studies, receiving a Ph.D. in economics from Yale. I currently hold a one-year appointment as a Lecturer at Yale while my wife (Page Laws, Wellesley, '74) completes her residence requirement in comparative literature, also at Yale. Right now, I'm looking for a new job, perhaps as an assistant professor somewhere. Jobs anyone?" . . . **Mark J. Ablowitz** has been named as a Sloan Foundation Fellow, 1975-77 and has been named an Associate Editor of the *Journal of Mathematical Physics*. . . . **Donald Raila** writes: "In June I received my doctorate in mathematical engineering from Princeton University, and have found employment as an engineer with Grumann Aerospace Corp. in Bethpage, N.Y. After so many years of school I am glad at long last to have the opportunity of doing something practical."

I received two very length press releases about **Paul F. Agris** from the University of Missouri-Columbia. Paul is working under a three-year grant by the National Cancer Institute of the National Institutes of Health doing in-depth research into the commonest forms of blood cancer, hoping to expand his research to encompass the rarest forms of leukemia. The American Society for Cell Biology has accepted his paper, co-authored by Carl Kardinal of the Ellis Fischel State Cancer Hospital, on leukemia protein production. Working under another award from the Research Council of the University of Missouri, Paul has developed a technique for studying the shape of translator molecules in collaboration with Dr. Richard Loeppky, Dr. Charles Schmidt, and F. Genichi Fujiwara. Fujiwara presented the results of their work to a national meeting of the American Chemical Society in Chicago this past August. These molecules are important because they are the cell's sole means of translating genetic information into protein. Knowledge of the shapes of these molecules is important since disturbances of them can cause faulty protein production which could, in turn, be responsible for many diseases affecting all forms of life. Inaccurate protein production may also be part of the process of aging. Sounds like the work Paul is doing could benefit us all.

Keep the cards and letters coming. The amount of news published here depends on each of you. I have noticed a small number of responses from alumni living out of the U.S. Please write and let everyone know where you are and what you are doing. — **Hal Moorman,** Secretary, 3461 McFarlin, Dallas, Tex. 75205

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Steven Lerman was appointed Assistant Professor in Course I at M.I.T. He has developed study designs in many areas of urban transportation, with emphasis on household relocation decisions and land use modeling. . . . **Paul Hooper** has graduated from an instructor pilot course and is assigned to Laughlin A.F.B. in Texas. . . . **Ahmad Salih,** who until last summer was one of my G.E. colleagues, is now doing graduate work at Stanford in aeroengineering.

Brad Billetdeaux writes, "My two-year assignment in South Africa ended last September. I was sent to Cape Town by Caltex Petroleum to learn the refining business, and I got a good introduction. Now I'm back at the headquarters office in New York doing planning work. My primary concern is looking at various investment options for Caltex refineries in Australia and the Philippines. The pace of work here is much slower. We don't have any crises in the manufacturing plant as was always the case at Cape Town. But the intellectual challenge is greater. My wife, Susan (Wellesley '72), is working at the U.N. in the language training service."

I thought you all might be interested in this account of a trip by **Shabbir Nomanbhoy.** "I just got back from a fantastic trip to Hunza in north Pakistan. It's incredibly green and beautiful, and the Indus flows fast and dangerous this time of year. The highest village is at 12,000 ft., and the road goes up to 15,000. The other side of the pass is China. The Chinese are building a road through Hunza, ostensibly for trade. **Amin Lakhani** and I took a jeep up to Passu. The jeep, a relic of the second World War, was literally held together by bits of string and wood. The front seat on these difficult roads is intended for the driver and one passenger. Of our nine riders, we had four in the front seat — two on the driver's right and one squeezed in on his left. Four people sat on wheat bags and one perched on the front bumper. This last guy serves a useful purpose, as he shifts around to balance the weight and also jumps off to remove rocks in the road.

"From Passu we walked back to Gilgit. Our poor city feet had nice blisters by then. It was extremely hot and we had one waterless 18-mile stretch at an average height of 9,000 feet. People were most hospitable, offering a meal or at least a cup of tea at every village.

"From Gilgit we went to Skardu. The jeep this time was in better condition and there were only two passengers, but the road was narrower than the jeep in places. Half the wheel was over the edge. My side was a 2,000-ft. drop to the oily, frothing Indus. Have you heard of V-turns, — or W's? These came in three dimensions — up and down as well as side to side. It took us 24 hours to make 150 miles, and we weren't dawdling. The driver was really very good, probably aided by the hash he was smoking. In order to put us at ease, no doubt, he kept pointing out where jeeps had gone off the road — at an average rate of one jeep a month. No question of survivors. We decided to fly back." — **Dick Fletcher,** Secretary, 135 West St., Braintree, Mass.

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Class of '73 where are you? And what are you doing? Over the last two years I have heard from less than 100 of you (and some of *you* haven't been heard from in quite some time)! In fact, the most recent news I have dates from October. This column is for you. Think of it as a time, energy and money saver. One letter to this column will reach many of your friends and you won't have to suffer from writer's cramp or support the inefficient postal system! And now to report the news (no matter how stale).

This spring **William Stern** married Sarah Newberger, a graduate student in creative writing and completed his second year at Mt. Sinai School of Medicine. . . . **Joel Franck** did graduate work in neurophysiology for two years at Rockefeller University and published several articles. He transferred to Yale Medical School in September. . . . **Elliott Borden** is working full time at the General Electric Reentry and Environmental Systems Div. as an electrical engineer. He is also a part-time graduate student at the College of Engineering and Applied Science of the University of Pennsylvania. He expects to receive his M.S.E. in December and attend Wharton while continuing to work at G.E. . . . **William Hsieh** completed his second year in the M.B.A. program at Wharton and **Marian Sonnenfeld** her second year at Albert Einstein College of Medicine. . . . **Jeffrey Seltzer** is in his third year at the University of Buffalo Medical School. He writes, "I still miss the M.I.T. approach. I think M.I.T. should have a medical school. It would stress thinking, not memorizing!" . . . **Robert Shaw** is in the Ph.D. program in

plasma physics at Berkeley.

Doug Levene received a Masters in East Asian Studies from Yale. He writes, "I am currently looking for a job either as a journalist on Capitol Hill or at the State Dept., but it looks like I'm going to end up back in the mines in Colorado." . . . **Robert Frye** returned to the Institute this fall after working two years for Texas Instruments doing research on charge coupled devices. . . . **Peter Borden** is "at Stanford, enjoying the California sunshine and chugging along in the applied physics Ph.D. program. Hiroshi Komine, '72, (recently married) and **John Edighoffer** are also here. We bolster each others' spirits a lot with talk of the good old days." . . . **Gary Waxman** completed his second year at Yale Law School. He claims to have learned that "M.I.T. isn't the only place that could stand a good deal of improvement."

Steven Book writes, "My wife, Maureen, and I enjoy the clear cool weather of San Francisco. We now practice the practical technology of gaining deep rest twice a day and returning to activity energized — Transcendental Meditation." . . . **Geoffrey Churchill** is in the research dept. of Monsanto's Springfield, Mass., plant as are numerous other Institute graduates. He enjoys Springfield and his work and is active in the company tennis league and St. Andrew's Church of Longmeadow. . . . **Glenn Sharfin** is in his final year of medical school at S.U.N.Y. at Stony Brook. Due to a lighter work load than at the Institute, he and his wife Phyllis have been spending their weekends visiting Long Island's beaches and woods. . . . **Peter Stiller** received his masters in math from Princeton in October, 1974, and is continuing for a doctorate. . . . **Bert Krusor, Willy Shih** and **Dave Cincotta** finished their second year in the chemistry dept. at Berkeley where **Jack Cavagnaro** is in chemical engineering.

Nancy "Laddie" **Cook** was divorced from Bob Slutz, '72, in March, 1974. She has been working for Arthur D. Little since September, 1974. She spent "two weeks rafting down the rapids in the Grand Canyon — great trip. I recommend it to everyone." . . . **John Caesar** did graduate work in geology at the University of Colorado where he worked this summer while studying for his second round of orals. . . . **Steven Richardson** finished his first year at Harvard Business School while **Daniel Leemon** graduated from Stanford Business School in June. Dan is working as a marketing systems analyst for TRW Industrial Operations in Los Angeles. . . . **Sylvia Weatherford** received her masters from U.S.C. in electrical engineering and is employed by Hughes Aircraft Satellite Systems in El Segundo, Calif. . . . **Fred Wiener** was married to Léni Levenson of Simmons College in August, 1974. In June, 1975 he "graduated with a law degree from Oxford and spent part of the summer touring the Soviet Union." He is presently at the University of Toronto Law School.

James Reuss writes, "My first year as an M.I.T. graduate was spent as a systems analyst (including operating systems as well as applications design) at the scientific computing facility of St. Louis University. This carefree phase of my life ended in a September marriage to the former Patricia Amy Higgins, herself a computer professional and graduate of St. Louis University. After a short (36-hour) honeymoon, I began my first year of medical school at the Chicago campus of the University of Illinois. I shall soon start concurrent graduate work in the field of cybernetics through the Dept. of Bioengineering. Amy and I play house in the suburb of Oak Park, that village of 'wide lawns and narrow minds;' the lawns are hardly wide, however. To everyone I'd like to write (you know who you are): get in touch, I've lost track of you!"

Jonathan Dietz says, "After graduation in Course VII in June, 1973, I re-enrolled at M.I.T. in Course VI, for lack of anything better to do. After a year and a half of tooling away, I received my degree in February, 1975, specializing in bioelectronics. I spent a month or so going to a lot of Placement Office interviews with a lot of pig industrialists and bomb-makers. I then began hanging around the West Roxbury Veterans Hospital, doing some E.E. hacking and going through a lot of Civil Service hassles. Finally, in August, 1975, I was hired as a biomedical engineer, in which position I am now serving." . . . **Athar Pasha Ahmad** spent another year at M.I.T. as a researcher for the Sahel-Sudano Project, and then moved to Cleveland to work for Standard Oil of Ohio as a controls engineer.

And last but not least, **Dan Dern** sends some new facts . . . "I've moved to West Cherter, Penn., and in March, 1976, I'm joining Robin Braverman in a nice Jewish feminist marriage. I've got two s-f stories due in *Analog* fall/winter '75; I've been doing music reviews for the *Globe, Real Paper* and got a monthly column in *Nightfall;* covering the 8th annual NOW National Conference (with Robin) for the *Drummer* (Philadelphia ground-level weekly); and doing odd consulting in technical writing as an English-to-English translator for First Data — summer '75 was spent on the Dial-A-Ride manual in Building 1 basement. No novels sold yet. . . . Other class of '73 gossip you can sneak in — **Louis Stuhl** is still gunning for his Chemistry Ph.D. at Cornell — 'They gave me my masters as a booby prize to keep me working.' . . . **Tom Dimino** is still in medical school in Buffalo. . . . **Bob Cava** is taking tap dancing lessons. . . . **Warren Trachtman** convinced ComSat he should be sent on a two-month mission to test a new antenna — conveniently Hawaii turned out to be just far enough away."

Yours truly is working as Assistant to the Treasurer of an investment/real estate company and attending B.U. at night in accounting. I've moved, so please note the new address. — **Joy Judell,** Secretary/Treasurer, 483 Beacon St. #25, Boston, Mass. 02115

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John Walsh writes: "Out here in California work is enjoyable and life is interesting. I'm working for U.S. Suzuki Motor Corp. trying to be innovative or at least effective in developing programs to control noise from some of those excessively noisy motorcycles that find their way onto the street." . . . **William E. Peak** writes, "I have worked at Aqua Chem in Milwaukee as an applications engineer for a year and a half now. I married a local girl on August 16, 1975. We are active members of the Good Hope Methodist Church. Business trips have taken me to Puerto Rico and Pittsburgh, and a trip to New Mexico is under consideration." . . . **Ted Kochanski** writes, "Still active, working on my Ph.D. in plasma physics at the University of Texas at Austin."

Fujio Hayashi is currently working for Xerox Corp. in Rochester, N.Y. . . . **Naomi Markovitz** is "working towards an M.A. in math education at Teachers College of Columbia University." . . . **Ed Ringel** writes, "Still alive and kicking in Philly. Med School gets better and better as time passes." . . . And **Steve Pearlman** is "still employed, fortunately!" . . . **James R. Groff** and **Douglas B. Fried** have received first-year honors at Harvard Business School.

I regret to report the death of **Michael E. Mackintosh,** on January 6, 1976.

There is no more to say — **Dennis Dickstein,** 16A Forest St., Apt. B1, Cambridge, Mass. 02140

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I recently received a note from **Tom Hui,** my regional representative in New York. He writes, "I have been in New York City for four months and have decided that Boston is a much nicer city to live in. Medical school has been quite tiring as most first-year students will attest to. I am joined here at N.Y.U. with **Bob Sadock** and **Eric Katz** as well as **Greg Rothman.** I've also run into **Dong Park** and **Bill Ntoso** at Albert Einstein.

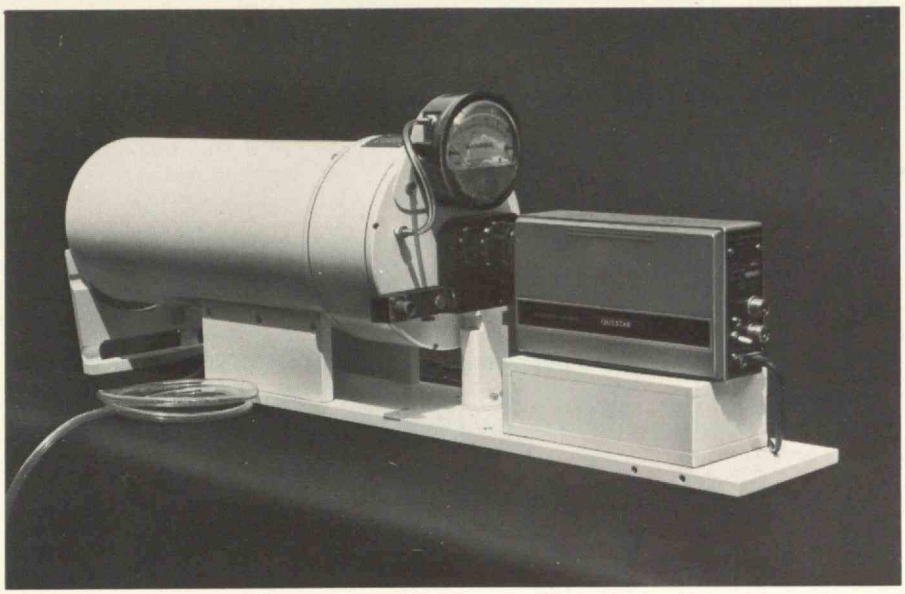
"I saw **Barbara Freeman** who's at Mt. Sinai. From Japan, I received a letter from **Yosuke Mishiro,** who's working for Mitsubishi Co. Also, I've heard from **Dave Lee** who's at U.C., Berkeley, and **Eve Higginbotham** at Harvard Medical School." Tom asked me to mention that he'd be interested in hearing from any classmates living in the New York City area. His address is: 24 Monroe Rd., Princeton, N.J. 08540.

As for other classmates, **Leo R. Katzenstein** is currently a graduate student in mathematics at the University of Chicago. . . . **David Jessich** is working as a petroleum engineer in offshore production for the Arabian American Oil Co. He says, "Living in the desert certainly is different than Back Bay, Boston." Yes, I understand it's a lot more sheik.

I also received a couple of letters from my most faithful correspondent, **Jeff Schweiger,** ensign in the U.S. Navy. He says that he's finally flying, and he also mentioned that he's a member of the Naval Air Training Command Choir. As a matter of fact, he and the group went on a five-day trip to California where they sang at Candlestick Park for a San Francisco '49ers football game. Some people will do anything to get into these N.F.L. games.

I had the pleasure of spending a day in Manhattan with my favorite fraulein **Betty Spiess** who's a graduate student in organic chemistry at Columbia University. After making a sad attempt to get some shopping done on 5th Avenue, we headed downtown to China Town where we ended up having a mini class reunion over a couple of Budweisers in a Chinese bar. Betty seems to be doing fine at Columbia, and last term she enjoyed the experience of T.A.'ing an undergraduate chemistry course.

It sure would be good to hear from those of you with time to write. — **Jennifer Gordon,** Secretary-Treasurer, 5 Centre St., Apt. 32, Cambridge, Mass. 02139



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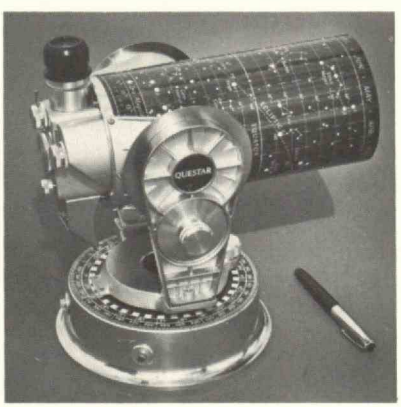

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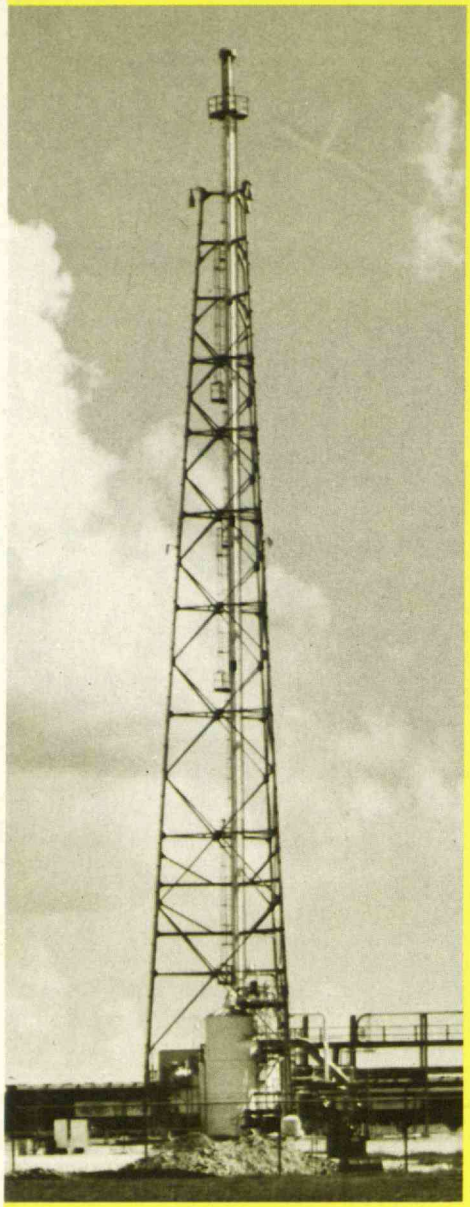

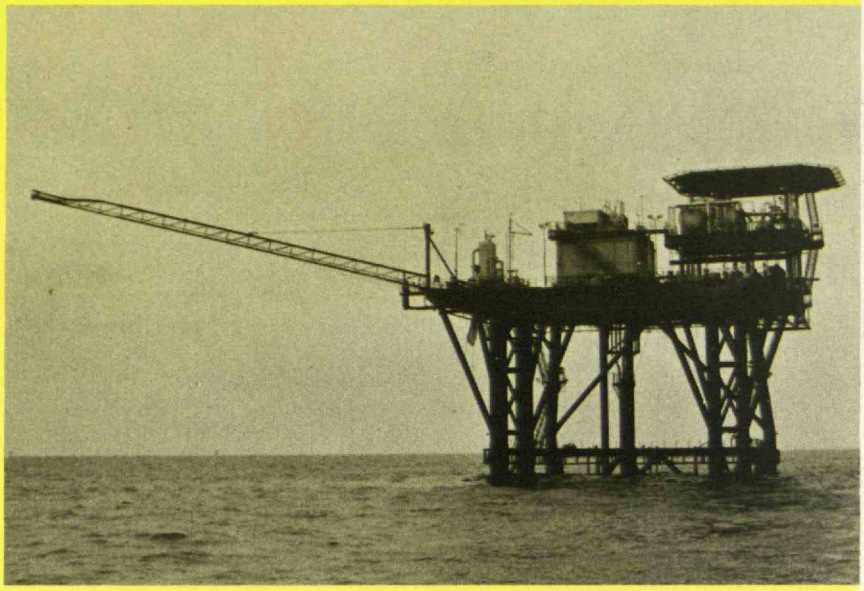

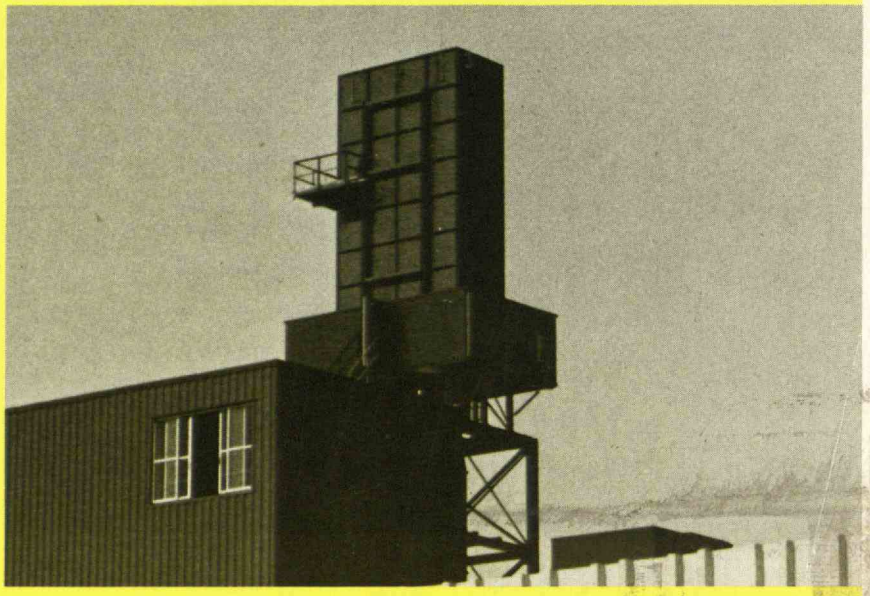

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